

## Twenty new species of *Paraboea* (Gesneriaceae) from Thailand

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**ABSTRACT.** Twenty new species of *Paraboea* are described from Thailand: *Paraboea arachnoidea* Triboun, *Paraboea axillaris* Triboun, *Paraboea bhumiboliana* Triboun & Chuchan, *Paraboea doitungensis* Triboun & D.J.Middleton, *Paraboea eburnea* Triboun, *Paraboea insularis* Triboun, *Paraboea lavandulodora* Triboun, *Paraboea monticola* Triboun & D.J.Middleton, *Paraboea nana* Triboun & Dongkumfu, *Paraboea nobilis* Triboun & D.J.Middleton, *Paraboea peninsularis* Triboun & D.J.Middleton, *Paraboea phanomensis* Triboun & D.J.Middleton, *Paraboea quercifolia* Triboun, *Paraboea rosea* Triboun, *Paraboea sangwaniae* Triboun, *Paraboea siamensis* Triboun, *Paraboea takensis* Triboun, *Paraboea tenuicalyx* Triboun, *Paraboea vachareea* Triboun & Sonsupab and *Paraboea xylocaulis* Triboun. Full descriptions and conservation assessments are provided for all taxa.

**Keywords.** Gesneriaceae, IUCN conservation assessments, *Paraboea*, Thailand.

### Introduction

*Paraboea* (C.B.Clarke) Ridl. is one of the larger genera in the Gesneriaceae (Weber, 2004) and has recently been revised by Xu et al. (2008) who recognised 89 species and five varieties. Since the publication of the revision three more species have been described (Chen et al., 2008; Kiew, 2010). In addition the genera *Phylloboea* Benth. and *Trisepalum* C.B.Clarke have been synonymised into *Paraboea* (Puglisi et al., 2011), following the conservation of *Paraboea* against these other two names (Middleton et al., 2010). This broader genus concept has resulted in about 107 currently accepted species.

The Gesneriaceae are currently under revision for the *Flora of Thailand*. This project has involved intensive field work all over Thailand and has already resulted in a number of new discoveries (Middleton & Triboun, 2010; Triboun & Middleton, 2010). It has also yielded many collections that were not available to Burt (1984), for his synopsis of *Trisepalum*, nor to Xu et al. (2008), for their revision of *Paraboea*. In the revision by Xu et al. (2008) very many taxa were shown to be very locally endemic and consequently more recent collections of previously unexplored or underexplored limestone areas has revealed many taxa that are new to science. All of these are described in *Paraboea* but of these the following have the characters that would previously have qualified them as belonging to *Trisepalum*: *Paraboea axillaris*, *P. bhumiboliana*, *P. lavandulodora*, *P. nana*, *P. nobilis*, *P. peninsularis*, *P. phanomensis*, *P. sangwaniae*,

*P. siamensis*, *P. takensis* and *P. xylocaulis*. These make up a large proportion of the newly described species partly because *Trisepalum* has received considerably less research attention than *Paraboea* in recent years. Limestone areas in Thailand still require considerably more exploration. We estimate that about 60% of karst limestone in Thailand has been unexplored and of the remaining 40% about half has had only the minimum of collecting possible at the site.

Xu et al. (2008) noted the desirability of providing IUCN conservation assessments for all species of *Paraboea* under IUCN criteria (IUCN, 2001), especially given the prevalence of *Paraboea* species in karst limestone habitats, a habitat that is under pressure throughout Southeast Asia, particularly due to exploitation for cement (see Clements et al., 2006). Since the publication of Xu et al. (2008) the more intensive field work in limestone areas of Thailand has indeed confirmed that most of the species thought to be rather locally endemic are indeed so. We, therefore, make some assumptions in order to provide these provisional IUCN conservation assessments: 1. we assume that species known only from the type or very few geographically restricted specimens really are confined to the area in which they were collected; 2. we assume that when the plant is known only from the type collection or from very few collections which were all collected from the same site its extent of occurrence (see IUCN, 2001 for definitions) is  $< 100 \text{ km}^2$  and area of occupancy is less than  $10 \text{ km}^2$ .

The Thai names adopted below have been coined by Pramote Triboun. The flowering and fruiting periods listed below are mostly estimated by comparing them to the phenology of similar and better known species and extrapolating from the fertile condition of the specimens when collected.

***Paraboea arachnoidea* Triboun, sp. nov. (Fig. 1A)**

*Paraboeae roseo Triboun magnitudine ubique magna, foliis rosulatis, planta pro parte maxima pilis arachnoideis dense oblecta et floribus densis similis, sed pilis arachnoideis in foliis magis densis, foliis ellipticis, pedunculis longioribus, corollis violaceis et capsulis brevioribus differt.* TYPUS: *P. Triboun*, B. Sonsupab & P. Yothakaew 4325, 2 September 2009, Thailand, Krabi, Mu Koh Lanta, Koh Lapu Le (holo BK; iso E).

Lithophytic perennial herb to subshrub. Stem erect, 15–40 cm high, c. 1.3 cm in diam., hard, woody, cracked and rough, the upper parts covered with white arachnoid hairs, the remains of old petioles and scars remaining in the lower parts, woody root stock stout. Leaves 11–25, arranged in a dense rosette at the top of the stem; petiole 2–6 cm long, c. 7 mm in diam., densely covered with white arachnoid hairs; blade subcoriaceous, elliptic,  $8.5\text{--}20 \times 3\text{--}5.5 \text{ cm}$ , apex obtuse, base cuneate or slightly attenuate, margin crenate, secondary veins 9–11 on each side of midrib, tertiary veins reticulate, densely covered with short multicellular glandular hairs but these somewhat obscured by dense white arachnoid hairs on both sides. Inflorescences 6–10, subterminal, compound pleiochasia, loosely congested 4–5 branches at each node, 4–8 orders of branching in each branch, 1–5 terminal orders mostly compound dichasia; peduncle

18–26 cm long, c. 4 mm in diam., densely covered with white arachnoid hairs; bracts elliptic or lanceolate,  $1.2\text{--}1.8 \times 0.3\text{--}0.7$  cm, the upper ones strongly reduced, densely covered with white arachnoid hairs, flowers paired; pedicels 3–4 mm, covered with white woolly hairs. Calyx green, fused for less than 0.5 mm at base, 5-lobed; lobes lanceolate, c.  $1.2 \times 0.6$  mm, apex acute, slightly covered with white hairs. Corolla violet-blue, with a short tube and spreading lobes; tube 1.5–2.5 mm long; 2 posterior lobes obovate or orbicular,  $3\text{--}3.8 \times 2.5$  mm, apex obtuse, inner margins overlapping each other, 3 anterior lobes ovate,  $2.5\text{--}3.5 \times 2$  mm, the 2 lateral ones asymmetrical, the middle one smaller than the lateral ones, apex rounded. Stamens 2, inserted near base of corolla tube; filament creamy white, c. 2 mm long, geniculate; anthers yellow, c.  $1.5 \times 2.5$  mm; staminodes strongly reduced. Ovary ovoid, c. 2 mm long; style white or light mauve, 3–4 mm long; stigma capitate, white or light mauve. Capsules cylindric, 0.8–1 cm long, c. 1.5 mm in diam., twisted, glabrous.

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* Open sun or in shade of dry evergreen forest on steep limestone cliff, alt. 10–200 m.

*Phenology.* Flowering and fruiting in July to October.

*Vernacular.* Cha Rue Si Yai Mang Mum (ชาฤๅษีไผ่แมงมุม).

*Etymology.* The specific epithet refers to the dense arachnoid hair covering.

*Proposed IUCN conservation assessment.* Endangered (EN D). This species is only known from the type locality which is in a legally protected area. Although the exact size of the population is uncertain we estimate that it is between 50 and 250 individuals.

*Notes.* *Paraboea arachnoidea* is most similar to another new species *Paraboea rosea* Triboun in its large overall size, the leaves in a rosette, the dense covering of arachnoid hairs on most parts and the dense flowers, but it differs in the denser covering of arachnoid hairs on the leaves, elliptic leaves, longer peduncles (18–26 cm long in *P. arachnoidea*, 10–15 cm in *P. rosea*), violet corollas and shorter capsules (0.8–1 cm in *P. arachnoidea*, 1–1.9 cm in *P. rosea*).

***Paraboea axillaris* Triboun, sp. nov.** (Fig. 1B)

*Paraboeae glandulosae* (B.L.Burtt) C.Puglisi *bracteis globosis, calyce distincte spectabili et floribus albis similis sed foliorum pubescentia, floribus paucioribus et capsulis longis tenuibus cylindricis differt.* TYPUS: *P. Triboun* 3608, 14 July 2006, Thailand, Tak, Umphang, Palata (holo BK; iso E).

Lithophytic perennial herb. Stem erect, 20–70 cm high, rarely branched, densely covered with brown arachnoid hairs, woody root stock short and finely striped. Leaves

8–12, the lower ones immediately above the root stock congested, opposite decussate, the upper ones on upright stems loosely opposite; petiole 1–6 cm long, the upper ones short, sulcate near base, densely covered with brown arachnoid hairs; blade papery, ovate, elliptic or orbicular,  $5\text{--}16 \times 5\text{--}8.5$  cm, apex obtuse, base cuneate, margin crenate, covered with multicellular glandular hairs above, densely covered with brown woolly hairs beneath, secondary veins 8–9 on each side of midrib, tertiary veins reticulate, venation prominent on both sides. Inflorescences 3–8, axillary, compound monochasia, the lower ones sometimes subtended by reduced leaves; peduncle 3–5.5 cm long, 1–1.5 mm in diam., glabrous or lightly covered with brown woolly hairs; bracts shiny green, globose, c. 1 cm, apex rounded or obtuse, glabrous; flowers paired, 2–5; pedicels 0.3–1 cm long, unequal, glabrous. Calyx cotyliform, light green, c. 1 cm long, 5-lobed, imbricate at base, upper 3 lobes fused at base; each lobe ovate or globose, c.  $3 \times 2$  mm, apex rounded, glabrous, 2 lower lobes free, ovate, c.  $2.5 \times 2$  mm, apex rounded, glabrous. Corolla white, campanulate; tube 0.8–1 cm long, slightly pale green at base; lobes globose or widely ovate,  $4\text{--}6.5 \times 6.5\text{--}8.5$  mm, apex rounded. Stamens 2; filaments white, c. 3 mm long, geniculate; anthers brownish yellow, c.  $2 \times 4$  mm; staminodes 3, narrowly linear, c. 1.5 mm long. Ovary ovoid, c. 3 mm long, glabrous; style white, c. 5 mm long; stigma linguiform, 5–7 mm long, grooved on the dorsal side. Capsules cylindric,  $1.8\text{--}2.2 \times 0.25$  cm, twisted, glabrous.

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* On limestone rocks in dry evergreen or mixed bamboo deciduous forest, alt. 600–900 m, in the same habitat as *Paraboea takensis* and *P. vachareeae*.

*Phenology.* Flowering and fruiting in June to October.

*Vernacular.* Khao Tok Rue Si (ข้าวตอกฤๅษี).

*Etymology.* The specific epithet refers to the distinct axillary inflorescences.

*Proposed IUCN conservation assessment.* Critically Endangered (CR B1ab(ii,iii,v)). This species is known only from the type locality. It is in a legally protected area but is subject to burning from adjacent agricultural practices. The extent of occurrence is  $< 100$  km<sup>2</sup>.

*Notes.* *Paraboea axillaris* is similar to *Paraboea glandulosa* (B.L.Burtt) C.Puglisi in its globose bracts, distinctly showy calyx and white flowers, but it differs in the pubescence on the leaves, the fewer flowers (2–5 in *P. axillaris*, 6–12 in *P. glandulosa*) and the long slender cylindric capsules (1.8–2.2 cm in *P. axillaris*, 2–2.7 cm in *P. glandulosa*).

***Paraboea bhumiboliana* Triboun & Chuchan, sp. nov.** (Fig. 1C–D)

*Paraboeae takensi* Triboun magnitudine ubique modesta, ramis tenuibus, floris magnitudine et calycibus gemmis juvenibusque cum pilis albis arachnoideis tectis similis, sed ramis multis, inflorescentiis brevibus, pedunculo brevi, bracteis minoribus et corolla pallide purpurea ad pallide malvina ad basin lobi inferiore cum macula flava orbiculari notata recedit. TYPUS: P. Triboun, T. Chuchan, S. Pintasean, C. Intasan & J. Sittikan 3980, 1 September 2007, Thailand, Lamphun, Li, Bhumibol dam, Mae Ping Rapid (holo BK: iso BKF, E).

Lithophytic perennial herb to undershrub. Stem erect or pendulous, 20–60 cm high, with 10–30(–50) branches, 10–40 cm long, slender, 2–5 mm in diam., all parts covered with dense white to pale brown hairs, lower part woody, straight or bent, 15–20 cm long, 1.2–1.7 cm in diam., bark brownish, root stock cracked and corky with parallel grooves. Leaves 5–14, opposite decussate, crowded towards the apex of each branchlet when in flower; petiole 3–7 mm long, winged, base amplexicaul and connected to the one opposite; blade coriaceous, elliptic, oblong, or ovate, 2.5–6 × 1.5–2.5 cm, apex obtuse, base cuneate or obtuse (the young ones attenuate), margin slightly crenate, secondary veins 6–8 on each side of midrib, prominent on both sides, densely covered with multicellular glandular hairs above, densely covered with white woolly hairs beneath, these extending beyond margin. Inflorescences 9–20, with a solitary flower or a short cyme of 2–5 flowers, terminal or subterminal, 1–2 flowers opening at a time, young bud densely covered with white arachnoid hairs; peduncle very short, less than 5 mm long; bracts leaf-like, lanceolate, 9–12 × 3–4 mm wide, apex obtuse or mucronate, appressed and close to the lateral sepals; pedicel very short. Calyx cotyliform, 6–8 mm long, 5-lobed, base slightly imbricate, upper 3 lobes fused at base; each lobe triangular, 1–1.5 mm long, apex reflexed and hooded, acute, 2 lower lobes free, elliptic or oblong, 3–6 × 3–3.5 mm, apex acute to acuminate, all 5 lobes green and covered with white arachnoid hairs. Corolla campanulate, c. 2 cm across; tube 1.4–1.8 cm long, limb bilabiate, lower lobe 3-lobed, upper lobe 2-lobed, not symmetrical, base of lobes slightly imbricate; lobes suborbicular, 0.8–1 cm long, 1–1.3 cm wide, apex rounded, pale purple to pale mauve with yellow circular patch at base of lower lobe. Stamens 2; filament white, flattened, somewhat parallel, upper part wider than lower part, 5.5–7 × c. 1.5 mm, fused to corolla tube near base; anthers 1.5–2.5 × 4–5 mm, creamy white or pale brown, mauve at juncture with filament; staminodes 3, narrowly linear, 1.8–2 mm long. Ovary 3–5 mm long, pubescent; style 6–7 mm long, sparsely hairy; stigma linguiform, 4–5 mm long, apex split into 2 lobes. Capsules ellipsoid, 1–1.5 × 0.3–0.5 cm, twisted, covered with dense arachnoid hairs, calyx persistent.

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* On limestone cliffs and slopes above the river in dry evergreen to mixed deciduous forests.

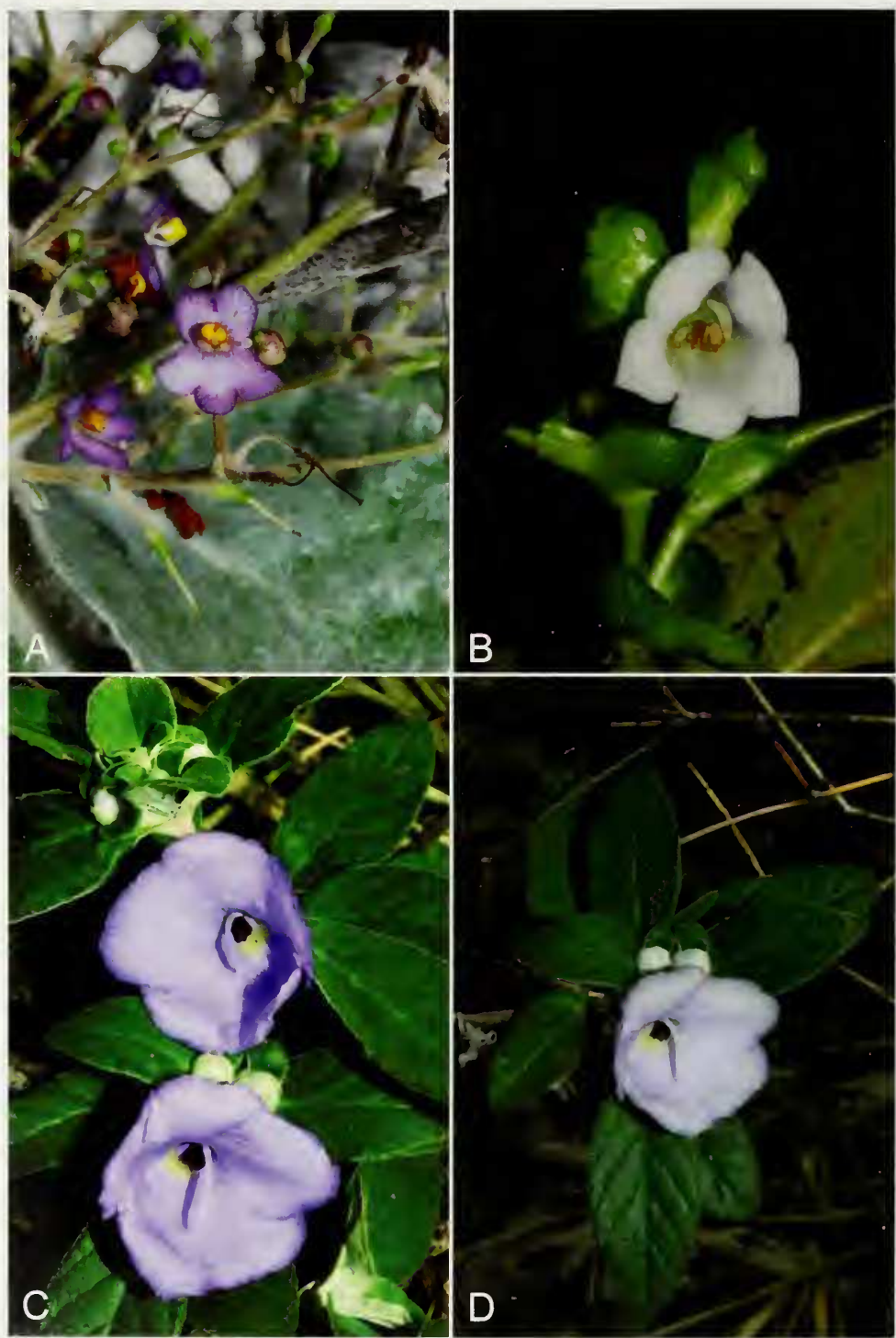


Fig. 1. A. *Paraboea arachnoidea* Triboun. B. *Paraboea axillaris* Triboun. C–D. *Paraboea bhumiboliana* Triboun & Chuchan. (Photos: P. Triboun)

*Phenology.* Flowering and fruiting in July to December.

*Vernacular.* Bhumibolin (ภูมิพลินทร์), name given by His Majesty King Bhumibol of Thailand.

*Etymology.* The specific epithet refers to the collection locality in the Bhumibol Dam area in Lamphun and Tak Provinces in Thailand. The name also honours His Majesty King Bhumibol of Thailand who has taken a keen interest in the conservation of forests and the relationship between people and the environment. This species is dedicated to him on the occasion of his 84<sup>th</sup> Birthday.

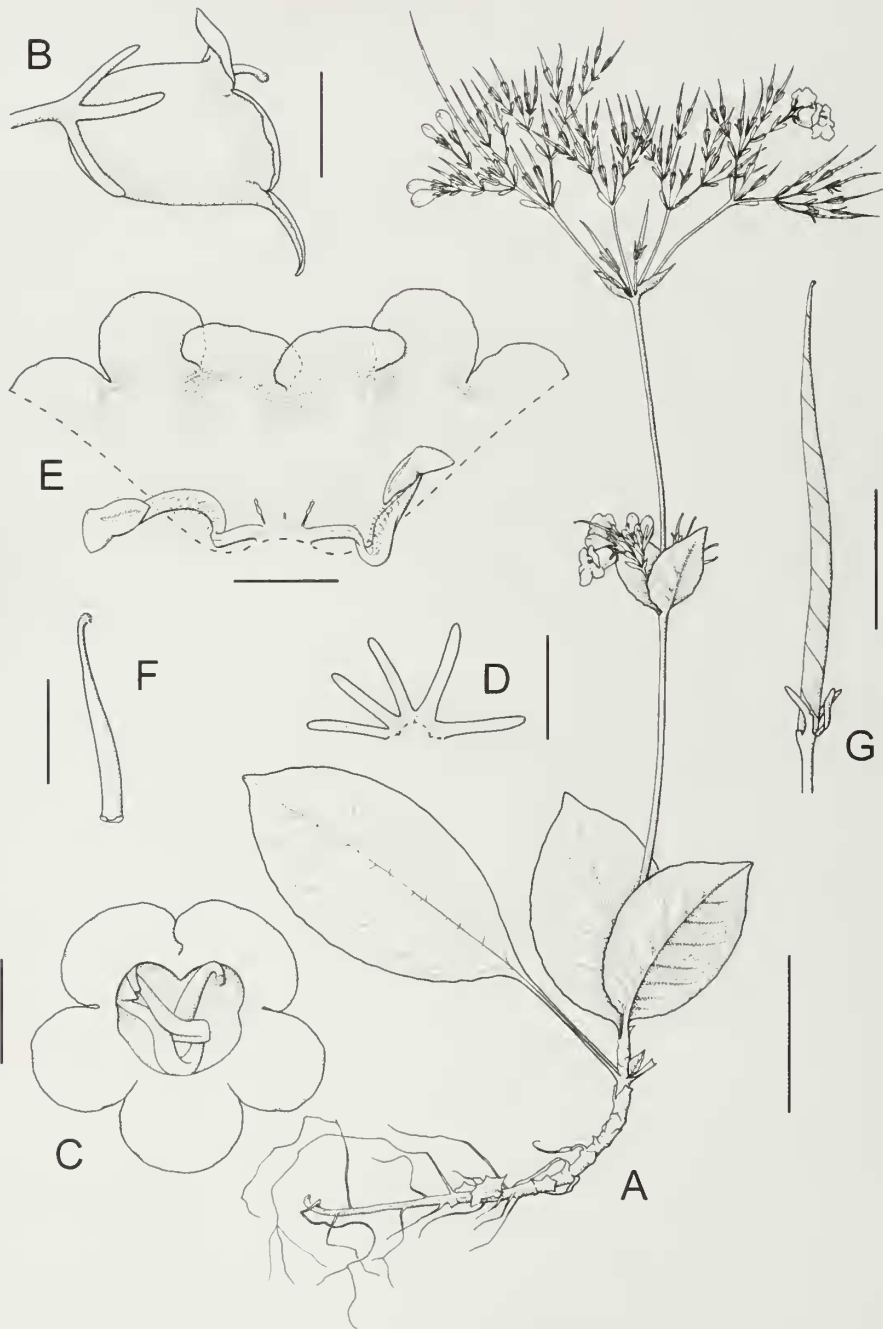
*Proposed IUCN conservation assessment.* Least Concern. Although this species is only known from the type locality it is on both sides of the boundary of two well legally protected areas and there are a few subpopulations.

*Notes.* *Paraboea bhumiboliana* is similar to the new species *Paraboea takensis* Triboun in its globose bracts, distinctly showy calyx and white flowers, but it differs in the pubescence on the leaves and often fewer flowers (2–5 in *P. bhumiboliana*, 2–8 in *P. takensis*).

***Paraboea doitungensis* Triboun & D.J.Middleton. sp. nov.** (Fig. 2, Fig. 3A–B)

*Paraboeae paramartinii* Z.R.Xu & B.L.Burt in *dichasio amplissimo composito terminali vel subterminali et capsulis longis cylindricis similis, sed calycibus spectabilibus, pedicellis brevioribus et bracteis floralibus majoribus obovatis recedit*. TYPUS: *P. Triboun & B. Sonsupab 4041*. 26 July 2008, Thailand, Chiang Rai, Mae Fah Luang District, Doi Tung (holo BK; iso E).

Lithophytic perennial herb. Stem erect, 10–30 cm high, more rarely up to 70 cm, woody root stock stout. Leaves 4–10, opposite decussate and congested at the apex of the stem; petiole narrowly winged, 6–12 cm long; blade papery, ovate, obovate or elliptic, 27–40 × 10.5–12.5 cm, apex acute, base narrowly attenuate onto petiole, margin indistinctly crenate, secondary veins 13–15 on each side of midrib, tertiary veins reticulate, venation obscure above and prominent beneath, mid green and glabrous above, lightly covered with brownish woolly hairs underneath. Inflorescences 1–2, terminal or subterminal compound dichasia, 3–4(–5) orders of branching in each compound dichasium, some congested with 3–4 branches; peduncle dark red or green, 8–35 cm long, 1.5–2 mm in diam., the upper order branching with axes (1.5–)10(–15) cm long; bracts cordiform or linear, the upper ones strongly reduced; flowers paired; pedicels 0.6–1.5 cm long. Calyx green, brown at tips, fused at base for c. 1 mm, 5-lobed; lobes narrowly cylindric, (4.5–)7–7.5 × 0.5–1 mm, apex round, glabrous. Corolla pink, campanulate; tube 7–9 mm long, very pale pink, tinted yellow at base; lobes orbicular or widely ovate, c. 5 × 6–7 mm, apex rounded. Stamens 2, inserted near base of corolla tube; filament creamy white, geniculate, 7–10 mm long, c. 1.5 mm



**Fig. 2.** *Paraboea doitungensis* Triboun & D.J.Middleton. **A.** Habit. **B.** Flower, lateral view. **C.** flower, front view showing enantiostyly. **D.** Calyx opened out. **E.** Corolla opened out. **F.** Ovary and style. **G.** Twisted fruit. Scale bars: A = 5 cm; B–F = 0.5 cm; G = 1.5 cm. (Drawn by Claire Banks)

wide; anthers creamy yellow, c.  $2 \times$  c. 4 mm. Staminodes 2–3, white or tinted pink at tip, cylindric, c. 2 mm long, medial staminode not apparent. Disc annular. Ovary ellipsoid, 4–6 mm long, c. 1 mm wide, green; style enantiostylous, white or pale green, 3–4 mm long; stigma capitate with glandular hairs. Capsules narrowly cylindric, 5–6.8 cm long, c. 1.8 mm wide, twisted, glabrous.

*Additional specimens examined:* THAILAND. **Chiang Rai:** Doi Tam Tu Pu, c. 520 m, 5 October 1924, *H.B.G. Garrett* 204 (K-2 sheets); Mae Fa Luang District, Doi Tung, 1365 m alt.,  $20^{\circ}19.6'N$   $99^{\circ}50.0'E$ , 23 September 2008, *D.J. Middleton*, *P. Karaket*, *P. Triboun*, *U. Kawatkul* & *R. Meeboonya* 4555 (BK, BKF, E); Mae Fa Luang District, summit of Doi Tung, 1510 m altitude,  $20^{\circ}19.6'N$   $99^{\circ}50.0'E$ , 23 September 2008, *D.J. Middleton*, *P. Karaket*, *P. Triboun*, *U. Kawatkul* & *R. Meeboonya* 4576 (BK, BKF, E).

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* Montane forest on summit of limestone hill, alt. 1100–1450 m.

*Phenology.* Flowering and fruiting in July to November.

*Vernacular.* Cha Rue Si Doi Tung (ชาภูซี้ดอยตุง).

*Etymology.* The specific epithet refers to the collection locality in Doi Tung, Chiang Rai Province in Thailand.

*Proposed IUCN conservation assessment.* Endangered (EN B1ab(iii,v)). This species is only known from Doi Tung and has an Extent of Occurrence of  $< 100 \text{ km}^2$  but is known from two distinct populations. The area is not protected and there has been a reduction in the quality of the habitat through large scale tourism and a reduction in the number of mature individuals.

*Notes.* Xu et al. (2008) included the specimen *Garrett 204* in *Paraboea paramartinii* Z.R.Xu & B.L.Burt but also suggested that further collecting could reveal that this is an undescribed species. New collections have indeed confirmed that this is a distinct and undescribed species. It is most similar to *Paraboea paramartinii*, with which it shares the characters of a large terminal or subterminal and glabrous inflorescence, papery leaves and long cylindrical capsules, and to *P. martinii* (H.Lév.) B.L.Burt and *P. glutinosa* (Hand.-Mazz.) K.Y.Pan, with which it shares the characters of a terminal or subterminal compound dichasium and long slender cylindrical twisted capsules. However it can be distinguished from these by the showy calyx.

***Paraboea eburnea* Triboun, sp. nov.** (Fig. 3C)

*Paraboeae variopilae* Z.R.Xu & B.L.Burt inflorescentiis, floribus et fructibus cum pilis glandulis multicellularibus omnino obtectis similis, sed ramis inflorescentiae

*compositis monochasialibus, foliis et floribus majoribus differt. TYPUS: P. Triboni, B. Sonsupab & P. Yothakaew 3835, 12 September 2007, Thailand, Ranong, Kraburi, Thum Pra Khayang (holo BK; iso E).*

Lithophytic perennial herb. Stem erect, 50–80 cm high, 7–8 mm in diam., greyish brown, woody, 4–6(–10) branches, hanging, young parts covered with rusty brown hairs, woody root stock stout. Leaves 10–20, loosely opposite decussate; sessile; blade papery, oblong, obovate or oblanceolate, 18–23 × 6–7.8 cm, apex obtuse, base attenuate, margin crenate or serrate, secondary veins 8–10 on each side of midrib, tertiary veins reticulate, venation prominent on both sides, sparsely covered in short glandular hairs above, densely covered with brownish woolly hairs beneath. Inflorescences 3–10 (2–4 on each branch), subterminal dichasia with 1(–2) orders of branching, each branch a compound monochasium (rarely dichasial), whole inflorescence densely covered with whitish multicellular glandular hairs; peduncle c. 4 cm long, c. 1.5 mm in diam.; bracts strongly reduced or absent; flowers paired; pedicels 7–9 mm long, covered by whitish multicellular glandular hairs. Calyx green, fused at base for less than 1 mm, 5-lobed; lobes lanceolate, c. 3 × 1 mm, apex obtuse, covered by whitish multicellular glandular hairs. Corolla white, with a short tube and spreading lobes; 2 posterior lobes ovate, c. 7 × c. 5 mm, apex obtuse, 3 anterior lobes oblong to obovate, 9–10 × 6–7 mm, apex obtuse or truncate, the middle lobe longer than the laterals. Stamens 2, inserted near the base of corolla tube; filament white, c. 3 mm long, geniculate; anthers yellow, c. 2.5 × 3.5–4 mm; staminodes 3, white, c. 2.5 mm. Ovary white, ellipsoid, c. 3.5 mm long, covered with short whitish multicellular glandular hairs; style white, c. 4.5 mm long, glabrous; stigma capitate, white. Capsules narrowly cylindric, 2.2–2.9 × c. 0.2 cm wide, twisted, covered with whitish multicellular glandular hairs.

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* On rock in shade in evergreen forest on an isolated limestone hill, surrounded by mangrove forest dominated by *Nypa fruticans*, alt. 50–100 m.

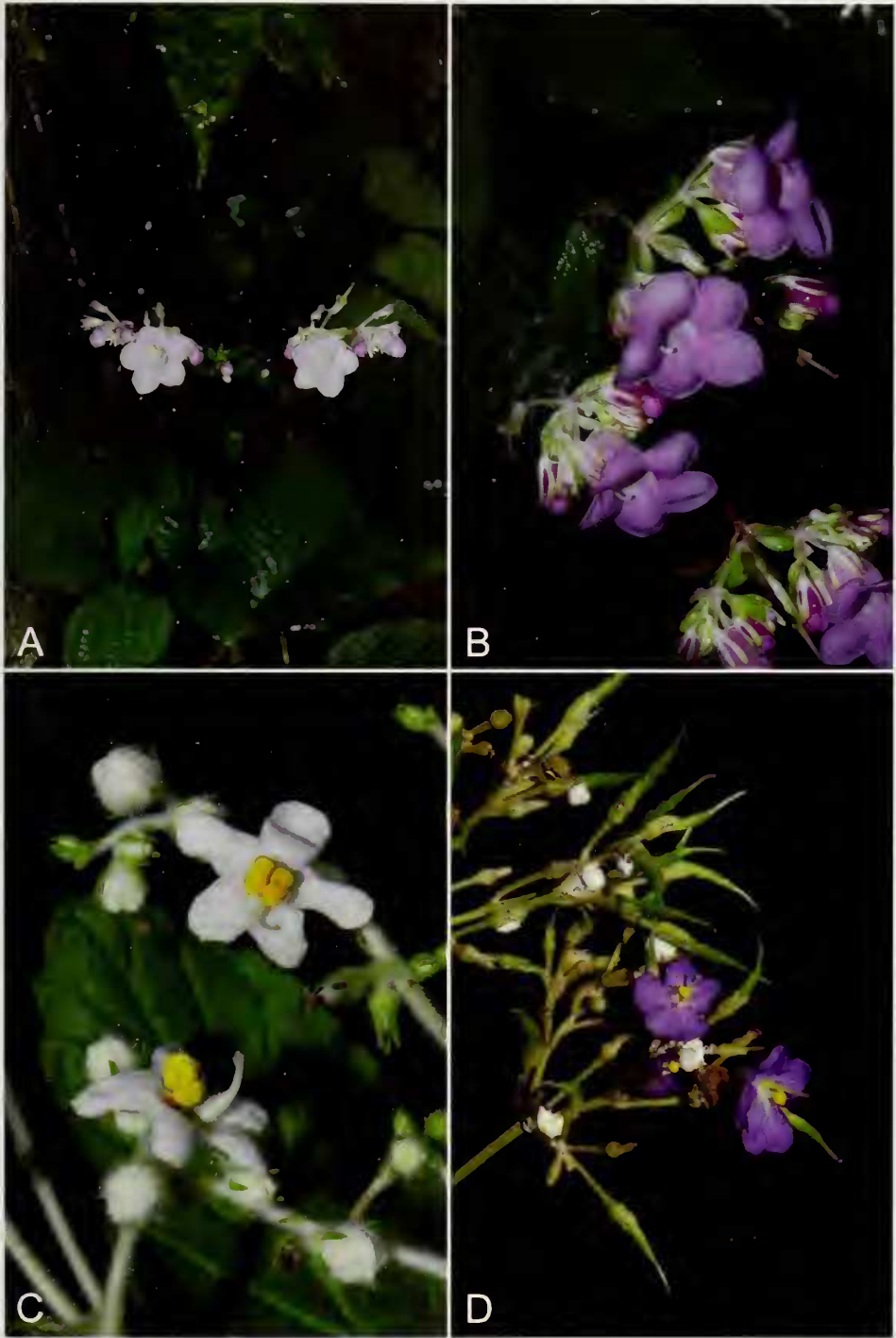
*Phenology.* Flowering and fruiting in late July to November.

*Vernacular.* Cha Rue Si Pra Kha Yang (ชาถ้ำพระขยงค์).

*Etymology.* The specific epithet refers to the white flowers.

*Proposed IUCN conservation assessment.* Critically Endangered (CR D). This species is only known from one small population at the type locality. The population is estimated to contain fewer than 50 individuals and the locality currently has no protected status.

*Notes:* *Paraboea eburnea* is similar to *Paraboea variopila* Z.R.Xu & B.L.Burt in the complete covering of multicellular glandular hairs on the inflorescences, flowers and



**Fig. 3.** A–B. *Paraboea doitungensis* Triboun & D.J. Middleton. C. *Paraboea eburnea* Triboun. D. *Paraboea insularis* Triboun. (Photos: P. Triboun)

fruits, but it differs in the compound inflorescence branches being monochasial, the larger leaves (18–23 cm long in *P. eburnea*, 5–17 cm long in *P. variopila*) and larger flowers (upper lobes c. 7 mm long in *P. eburnea*, c. 3.5 mm long in *P. variopila*).

***Paraboea insularis* Triboun, sp. nov.** (Fig. 3D)

*Paraboeae suffruticosae* (Ridl.) B.L.Burt in habitu et statura, foliis ellipticis usque lanceolatis, et florum fructuumque magnitudinum similis, sed partibus inflorescentiarum ultimis dense congestis et corollis violascenti-caeruleis differt. TYPUS: *P. Triboun*, B. Sonstupab & P. Yothakaew 4587, 25 September 2010, Thailand, Phangnga, limestone island border of Phang-gna-Krabi bay (holo BK; iso E).

Lithophytic perennial herb to subshrub. Stem erect, 7–20 cm high, solitary or with 2–4 twigs, 3–6 mm in diam., grey, deeply grooved and corky, root stock stout and rough. Leaves 8–16, arranged in a whorl or slightly opposite decussate, densely congested at the apex; petiole yellowish brown, 0.5–2 cm long, sulcate, densely covered with short brown woolly hairs; blade coriaceous, elliptic to lanceolate, 5–8 × 1.4–2.6 cm, apex acute, base cuneate, margin slightly crenate, glaucous, densely covered with multicellular glandular hairs above, densely covered with light brown woolly hairs beneath, secondary veins 14–17 on each side of midrib, prominent beneath, tertiary veins reticulate, obscure on both sides. Inflorescences 1–3, subterminal, mostly compound dichasium, rarely pleiochasial at first node, 3–4 orders of branching; peduncle green or brown, 5–9 cm long, c. 1.5 mm in diam., densely covered with short light brown hairs; bracts leafy, elliptic, 1–2.5 × 0.3–0.7 cm, apex obtuse, densely covered with light brown arachnoid hairs; the first order branch axis long and slender, 3–6 cm long, c. 0.5 mm in diam., densely covered with short light brown hairs, subtended by leafy bracts and without a flower at the branching point, the upper orders densely congested, less than 1 cm long; flowers paired; pedicels 0.3–1 cm long, densely covered with light brown hairs. Calyx light brown, fused at base for c. 1 mm, 5-lobed; lobes narrowly linear, 2–3.5 × c. 0.5 mm, apex obtuse, densely covered with light brown woolly hairs. Corolla violet-blue, with a short tube and 2-lipped spreading limb, tube 3–5 mm long, the lower lip much longer; 2 posterior lobes orbicular, c. 3 × c. 3 mm, apex rounded, 3 anterior lobes unequal, 2 lateral ones obovate, 3–3.5 × c. 3.5 mm, the middle one orbicular, c. 3.5 × c. 3 mm, apex rounded. Stamens 2; inserted near base of corolla tube; filament white, c. 3 mm long, geniculate; anthers yellow, c. 2 × c. 3.5 mm; staminodes 2, c. 1.5 mm long. Ovary creamy white, ellipsoid, c. 3 mm long, glabrous; style white, c. 3 mm long; stigma capitate, white. Capsules ellipsoid, 6–8 × 1.5–2 mm, twisted, glabrous.

*Additional specimens examined:* THAILAND. **Krabi:** Koh Hin Bai, 31 October 2006, *P. Triboun* 3673 (BK, E).

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* In open sun on limestone cliffs, alt. 10–150 m.

*Phenology.* Flowering and fruiting in July to November.

*Vernacular.* Sud Sa Khon (สุดสาคร).

*Etymology.* The specific epithet refers to the collection locality on limestone islands in Phangnga-Krabi Bay in Thailand.

*Proposed IUCN conservation assessment.* VU D1. Although this species is only known from the type locality this is in a legally protected area. It is difficult to estimate the population size as the plants are on inaccessible cliffs but is likely to be between 250 and 1000 mature individuals.

*Notes.* *Paraboea insularis* is similar to *Paraboea suffruticosa* (Ridl.) B.L.Burtt in its habit and overall size, elliptic to lanceolate leaves, flower and fruit sizes, but it differs in the densely congested ultimate parts of the inflorescences and the violet-blue corollas.

***Paraboea lavandulodora* Triboun, sp. nov. (Fig. 4A)**

*Paraboeae glabrescenti* (Barnett) C.Puglisi floribus binatis in monochasiis compositis densis aggregatis, bracteis globosis et corollis dilute caeruleis similis, sed foliis sessilibus, inflorescentiis brevibus et partibus plurimis cum trichomatibus glandulis viscidis tectis differt. TYPUS: *P. Triboun* 4433, vouchered from material flowering at BK on 11 April 2010, originally collected in the wild, Thailand, Bung Kan, Phu Tok (holo BK).

Lithophytic perennial herb. Stem erect, 16–45 cm high, 2–4 mm in diam., brown. Leaves 8–15, shortly opposite decussate; sessile; blade coriaceous, elliptic, lanceolate or obovate, 5–7 × 2–4 cm, apex acute, base broadly attenuate, margin serrate, covered with short multicellular glandular hairs on both sides, sticky, also covered with light brown arachnoid hairs, secondary veins 6–8(–10), prominent on both sides, tertiary veins reticulate. Inflorescences 2–3, subterminal or axillary; compound monochasia, rather dense; peduncle c. 9 cm long, 2–2.3 mm in diam., covered with multicellular glandular hairs, bracts green, globose, 0.8–1.1 × c. 1 cm, apex rounded or shallowly lobed, base slightly plicate, covered with multicellular glandular hairs; paired flowers 3–5; pedicels c. 7 mm long, unequal, green, covered with multicellular hairs. Calyx cotyliform, 5-lobed, upper 3 lobes fused at base; each lobe linear to elliptic, 7–7.5 × c. 3.5 mm, apex obtuse, 2 lower lobes fused together at the base, free from the upper ones, lobes lanceolate to elliptic, c. 8.5 × c. 3.5 mm, apex obtuse, covered by short glandular hairs. Corolla light blue, campanulate; tube 8–9 mm long; lobes widely ovate, 5.5–6 × 9–9.5 mm, apex rounded. Stamens 2, inserted near base of corolla tube; filament white, c. 4.5 × c. 1 mm, flattened, geniculate; anthers creamy yellow, c. 2 ×

c. 4.5 mm; staminodes 3, white, linear, c. 1.5 mm long. Disc annular, c. 0.3 mm high. Ovary light green, ellipsoid, c.  $3 \times c. 1.8$  mm, glabrous; style 5–5.5 mm long; stigma white, linguiform, c.  $3 \times c. 1$  mm, apex bilobed. Capsule not seen.

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* On sandstone cliffs in shade of mixed deciduous forest.

*Phenology.* Flowering in May to July (data only from cultivation).

*Vernacular.* Cha Rue Si Bai Hom (ชา Rue Si Bai Hom).

*Etymology.* The specific epithet refers to the mild lavender-like scent, particularly noticeable in the leaves of fresh plants.

*Proposed IUCN conservation assessment.* Near Threatened. This species is only known from the type locality which is in the grounds of a temple. This means that it has no formal protected status but is unlikely to be under any immediate threat. However, we are unsure of the population size and the total distribution of the species is restricted. It requires regular monitoring of its status to see if it requires a higher threat status.

*Notes.* *Paraboea lavandulodora* is similar to *Paraboea glabrescens* (Barnett) C. Puglisi in its paired flowers in dense compound monochasia, globose bracts and the light blue corollas, but it differs in the sessile leaves, short inflorescences (peduncle c. 9 cm long in *P. lavandulodora*, 10–15 cm in *P. glabrescens*) and having most parts covered with sticky glandular trichomes.

***Paraboea monticola* Triboun & D.J. Middleton, sp. nov.** (Fig. 4B–C)

*Paraboeae regulari* (Ridl.) Ridl. *magnitudine ubique parva et fructibus rectis similis, sed foliis tenuibus chartaceisque, petiolis multo longioribus et tenuibus, floribus fructibusque multis differt.* TYPUS: *P. Triboun* 3662, 25 September 2006, Thailand, Phangnga, Tai Toy (holo BK; iso E).

Lithophytic perennial herb or subshrub. Stem erect, 10–35 cm high, solitary or in clumps of 2–6 shoots, c. 4 mm in diam., light brown or grey, woody root stock slender and striped. Leaves 6–15, arranged densely in whorls or alternate and congested at the apex; petiole slender, (1.5–)4(–7) cm long, the ones lower on the plant longer, sulcate, densely covered with short brown hairs; blade papery, obovate, oblanceolate, ovate or elliptic,  $4\text{--}10.5 \times 2.5\text{--}5.5$  cm, apex acute, base oblique, cuneate or rounded, margin serrate or cuneate, glabrous above, densely covered with short hairs and furfuraceous beneath; secondary veins 7–10 on each side of midrib, tertiary veins finely reticulate, prominent on both sides. Inflorescences 5–15, axillary or subterminal, compound

dichasia, 2–4 orders of branching; peduncle thin and slender, 1–4 cm long, c. 0.5 mm in diam., furfuraceous; bracts reduced, linear,  $1\text{--}3.5 \times \text{c. } 0.3$  mm, the upper ones strongly reduced, apex acute; flowers paired, pedicels thin and slender, 0.5–1.5 cm, furfuraceous. Calyx greenish brown; fused at base for c. 0.5 mm long, 5-lobed; lobes linear, c. 2 mm long, apex obtuse, furfuraceous. Corolla white, with a short tube and spreading lobes; tube c. 1.5 mm long; lobes ovate to obovate,  $6\text{--}9 \times \text{c. } 6.5$  mm, apex rounded. Stamens 2, inserted near base of corolla tube; filament white, c. 2.5 mm, geniculate; anthers yellow, c.  $2 \times 2$  mm; staminodes strongly reduced, c. 1.5 mm, white. Ovary light green, ellipsoid, c.  $1.3 \times 0.7$  mm; style white, c. 2.5 mm; stigma capitate, white with green at tip. Capsules cylindric,  $0.8\text{--}1 \times \text{c. } 1.5$  mm, straight, glabrous or furfuraceous.

*Additional specimens examined:* THAILAND. **Surat Thani:** Phanom District. Khlong Phanom National Park, trail from Park headquarters, 200 m altitude,  $8^\circ 52'4''\text{N } 98^\circ 40'6''\text{E}$ , 7 September 2008, *D.J. Middleton, P. Triboun, V. Chamchunroon, S. Saengrit & R. Simma* 4363 (E); Phanom District, Khao Sok National Park, 100–200 m altitude, 12 December 1979, *T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara & C. Niyomdham* T-27069 (L). **Phangnga:** Muang Phangnga, 25 September 2006, *P. Triboun* 3662 (E); Pulau Panji, 2 December 1928, *Haniff & Nur* 4013 (K).

*Distribution.* Endemic to Thailand. Known only from Phangnga and Surat Thani Provinces.

*Ecology.* On shaded limestone rocks in evergreen forest, alt. 20–200 m.

*Phenology.* Flowering and fruiting in late June to October.

*Vernacular.* Cha Pho Ta Rue Si (ชาพ้อตาธารี).

*Etymology.* The specific epithet refers to its collection localities in low but rugged hilly areas in Phangnga and Surat Thani Provinces in Thailand.

*Proposed IUCN conservation assessment.* Vulnerable (VU B1ab(iii,v)). This species is relatively widespread over two provinces and known from several populations, some of which are in legally protected areas and others which are not. The Extent of Occurrence is  $< 20,000 \text{ km}^2$  and those populations not in protected areas are in decline due to habitat disturbance.

*Notes.* *Haniff & Nur* 4013 (K) was included in *Paraboea regularis* (Ridl.) Ridl. by Xu et al. (2008). Although *Paraboea monticola* is similar to *Paraboea regularis* in its small stature and straight fruits it differs in having thin papery leaves, much longer and slender petioles and many flowers and fruits. With the removal of *Haniff & Nur* 4013 from *Paraboea regularis* this species is now not known from Thailand.

***Paraboea nana* Triboun & Dongkumfu, sp. nov.** (Fig. 4D)

*Paraboeae birmanicae* (Craib) C. Puglisi magnitudine ubique parva, petiolis oppositis conjungentibus trans nodum auriculam formantibusque et floribus parvis similis, sed floribus in inflorescentia paucioribus, pedicellis robustis et corollis dilute caeruleis recedit. TYPUS: *P. Triboun & W. Dongkumfu* 4035, 18 July 2008, Thailand, Lamphun, Li District, Mae Ping National Park, Kor Noi Falls (holo BK; iso BKF, E).

Lithophytic perennial herb or subshrub. Stem erect, 10–25 cm high, few branches with many shoots, glaucous, woody root stock slender. Leaves 8–14, loosely opposite decussate; petiole brown, 1–1.3 cm long, forming an auricle with the opposite petiole at the node, sparsely covered with glandular hairs; blade coriaceous, ovate or elliptic, 3.2–5.3 × 1.4–2.4 cm, apex acute or obtuse, base cuneate, margin slightly crenate, densely covered with multicellular glandular hairs above, densely covered with brown wooly hairs beneath, secondary veins 3–5 on each side of midrib, prominent beneath. Inflorescence 1–2 flowers only, monochasia, subterminal and axillary; bract linear, c. 1 cm × 1.5–2 mm, light brown covered with white arachnoid hairs; pedicel robust, 2.2–3 cm long (up to 4 cm when fruiting), unequal, light brown covered with white arachnoid hairs. Calyx cotyliform, 5–6 mm long, 5-lobed, slightly imbricate at base, upper 3 lobes fused at base; each lobe ovate to obovate, c. 5 × 5–5.5 mm, apex obtuse, 2 lower lobes free, ovate to oblong, c. 4 × c. 5 mm, apex obtuse, covered with light brown arachnoid hairs. Corolla light blue, campanulate; tube light blue to nearly white, 8–9 mm long; lobes broadly ovate, c. 5 × 4.5–7 mm, apex rounded or obtuse. Stamens 2, filament white, c. 3 mm long, geniculate; anthers creamy yellow, c. 3 × c. 2 mm; staminodes 2, 0.5–0.6 mm long. Ovary subglobose, 1.5–2 mm long; style white, c. 3.5 mm long, covered with glandular hairs; stigma linguiform, c. 1.5 mm, white. Capsules ovoid, 1–1.4 cm long, twisted, covered with white arachnoid hairs, surrounded by persistent calyx.

*Distribution.* Endemic to Thailand. So far known only from the type locality.

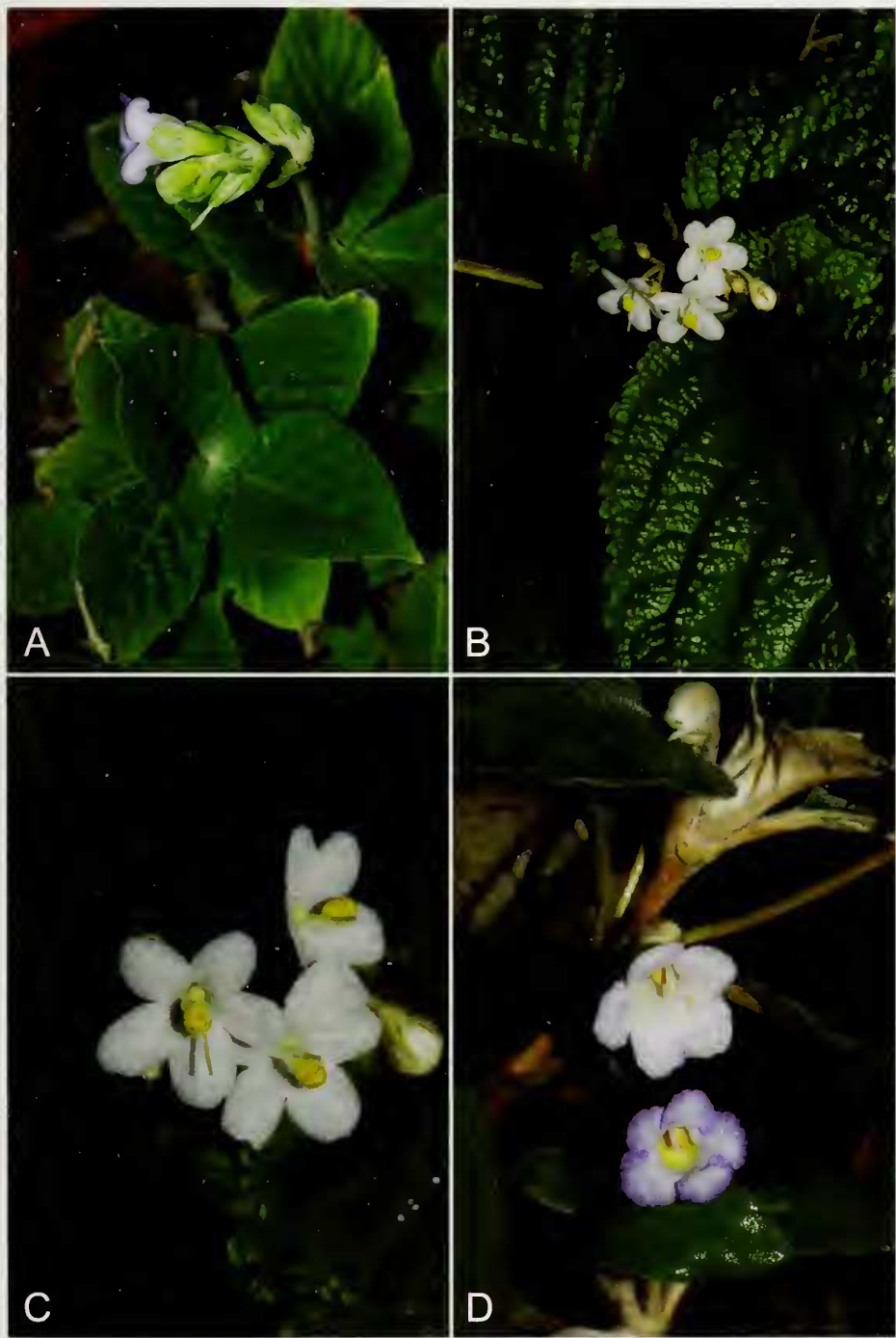
*Ecology.* On limestone cliffs in dry evergreen to mixed dipterocarp forests, alt. 600–900 m.

*Phenology.* Flowering and fruiting in late June to October.

*Vernacular.* Cha Rue Si Noi (ชาภูเขีน้อย).

*Etymology.* The specific epithet refers to the very small stature of the plant and the particularly small flowers amongst those plants previously referred to *Trisepalum*.

*Proposed IUCN conservation assessment.* Least Concern. Although this species is only known from the type locality it is on both sides of the boundary of two legally protected areas and there are a few subpopulations.



**Fig. 4.** A. *Paraboea lavandulodora* Triboun. B–C. *Paraboea monticola* Triboun & D.J. Middleton. D. *Paraboea nana* Triboun & Dongkumfu. (Photos: P. Triboun)

*Notes.* *Paraboea nana* is similar to *Paraboea birmanica* (Craib) C. Puglisi in its small overall size, the opposite petioles joining and forming an auricle across the node and the small flowers, but it differs in the fewer flowers in an inflorescence (1–2 in *P. nana*, 4–10 in *P. birmanica*), the robust pedicels and the light blue corollas.

***Paraboea nobilis* Triboun & D.J. Middleton, sp. nov.** (Fig. 5A)

*Paraboeae phanomensi* Triboun & D.J. Middleton pedunculo pedicelloque tenui, foliis lanceolatis et magnitudine ubique similis sed pedicellis longioribus, floribus paucioribus et majoribus, lobis corollae atriore caeruleis recedit. TYPUS: D.J. Middleton, P. Triboun, V. Chamchumroon, S. Saengrit & R. Simma 4312, 6 September 2008, Thailand, Surat Thani, Ban Thakhun subdistrict, Khao Sok National Park (holo BK; iso BKF, E, K, KEP).

Lithophytic perennial herb or small shrub. Stem erect, 25–50 cm high, branches many, c. 20 cm long, c. 6.5 mm in diam., woody root stock robust and rough. Leaves many, 10–15 on each shoot, arranged rather densely opposite decussate; petiole 1.5–2 cm long, sulcate, covered with light brown wooly hairs; blade coriaceous, lanceolate or oblong, 6–9 × 1.4–2.6 cm, apex obtuse or acute, base cuneate, margin indistinctly crenate, loosely covered with white arachnoid hairs above, glaucous and densely covered with light brown wooly hairs beneath, secondary veins 10–13 on each side of midrib, tertiary venation not visible, prominent on both sides. Inflorescences 4–5, subterminal or axillary, mostly a single flower or rarely 1 pair of monochasia; bracts brown, coriaceous, globose, 1.3–1.5 cm, hooded, lightly rugose, apex rounded or acute, a protruding bulge present around the middle to base on the outside, outside light brown and densely covered with wooly hairs, inside green and glabrous; pedicel and peduncle 3–5.5 cm long, c. 1.3 mm in diam., densely covered with wooly hairs. Calyx cotyliform, tube 5–6 mm long, 3-lobed; lobes obovate, dorsal lobe c. 1.2 × c. 0.9 cm, lateral lobes c. 1 × c. 0.6 cm, apex acute, margin fimbriate, densely covered with light brown wooly hairs. Corolla campanulate; tube white, c. 1.5 cm long; lobes violet-blue, widely globose or widely ovate, 1.2–1.5 × 1.3–1.5 cm, apex rounded, margin plicate and fringed. Stamens 2; filaments white, c. 5 mm long, geniculate; anthers yellowish brown, c. 4 × c. 6 mm; staminodes 3, linear, 2–2.5 mm long. Ovary ovoid, c. 5 × c. 3 mm, covered with white arachnoid hairs; style white, c. 7 mm long; stigma linguiform, c. 8 mm long, white. Capsules woody, ellipsoid, c. 2.7 × c. 0.7 cm, twisted, glaucous and loosely covered with white arachnoid hairs, surrounded by persistent calyx.

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* On limestone rocks in evergreen forest, alt. 100–300 m.

*Phenology.* Flowering and fruiting in May to October.

*Vernacular.* Sri Ra Cha Pra Pha (ศรีรัชประภา).

*Etymology.* The specific epithet refers to its large and spectacular flowers, coupled with an attractive leaf shape, all in pleasant proportion to the size of the plant.

*Proposed IUCN conservation assessment.* Endangered (EN D). This species is only known from the type locality which is in a legally protected area. Although, the exact size of the population is uncertain we estimate that it is between 50 and 250 individuals.

*Notes.* *Paraboea nobilis* is most similar to another new species, *Paraboea phanomensis* Triboun & D.J. Middleton, in its slender peduncle and pedicel, lanceolate leaves and overall size, but it differs in longer pedicels (3–5.5 cm in *P. nobilis*, 2–6 mm in *P. phanomensis*), fewer (1–2 in *P. nobilis*, 2–5 in *P. phanomensis*) and larger flowers (corolla tube 1.5 cm in *P. nobilis*, 1–1.3 cm in *P. phanomensis*) and darker blue corolla lobes.

***Paraboea peninsularis* Triboun & D.J. Middleton. sp. nov.** (Fig. 5B–C)

*Paraboeae barnettiae* C. Pnglisi in habitu et statura, foliis lanceolatis, inflorescentiis longis et capsulis tortis cylindricis similis sed foliorum apicibus acutis, bractearum apicibus rotundis et corollis albis differt. TYPUS: *P. Triboun* & *P. Yothakaew* 4300, 31 July 2009, Thailand, Krabi, Hat Nop Parat Thara (holo BK: iso E).

Lithophytic perennial herb to small shrub. Stem erect, 20–65 cm high, 10–20 branches, 10–20 cm long, c. 2 mm in diam., woody root stock thick and rough. Leaves many (10–20 on each shoot), loosely opposite decussate; petiole 0.6–1.5 cm long, sulcate, densely covered with short brown hairs; blade coriaceous, lanceolate, 6.5–10 × 2.3–3 cm, apex acute, base cuneate, margin indistinctly crenate, secondary veins 7–10 on each side of midrib, prominent beneath, above shiny green and glabrous, densely covered with brownish woolly hairs beneath. Inflorescences 1–2, subterminal, compound monochasia, c. 6 cm long; peduncle 5–7 cm long, c. 2 mm in diam., square in cross-section, densely covered with light brown woolly hairs; bracts globose, 1.4–1.7 cm, apex rounded, hooded, outside densely covered with light brown woolly hairs, inside green and glabrous; flowers paired c. 6; pedicels 2–8 mm long, unequal, densely covered with light brown woolly hairs. Calyx cotyliform c. 1 cm long, 3-lobed, almost free; lobes globose, c. 1.3 cm, apex rounded or obtuse and fimbriate, densely covered with light brown woolly hairs. Corolla white, campanulate; tube c. 1 cm long; lobes orbicular, c. 0.6 × 0.9–1.1 cm, apex rounded. Stamens 2; filament creamy white, 4–5 mm long, geniculate; anthers yellow, c. 2 × c. 4 mm; staminodes 2, linear, c. 2.5 mm long. Ovary ovoid, c. 4.5 × c. 2 mm, densely covered with woolly hairs; style white, c. 6.5 mm long; stigma linguiform, 3.5–4 mm long, white. Capsules cylindric, c. 2 × c. 0.5 cm, twisted, densely covered with light brown woolly hairs.

*Additional specimens examined:* THAILAND. **Krabi:** Muang Krabi District, Ko Phi Phi National Park, small limestone island on Nop Parat Thara Beach, alt. 5 m, *D.J. Middleton, P. Triboun, V. Chamchumroon, S. Saengrit & R. Simma 4449* (BK, BKF, E).

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* On rocks in dry evergreen forest on limestone island near shore, alt. 20–100 m.

*Phenology.* Flowering and fruiting in June to October.

*Vernacular.* Sin Sa Mut (สินสมุทร).

*Etymology.* The specific epithet refers to Peninsular Thailand in which Krabi Province is to be found.

*Proposed IUCN conservation assessment.* Endangered (EN D). This species is only known from the type locality which is in a legally protected area. Although, the exact size of the population is uncertain we estimate that it is between 50 and 250 individuals.

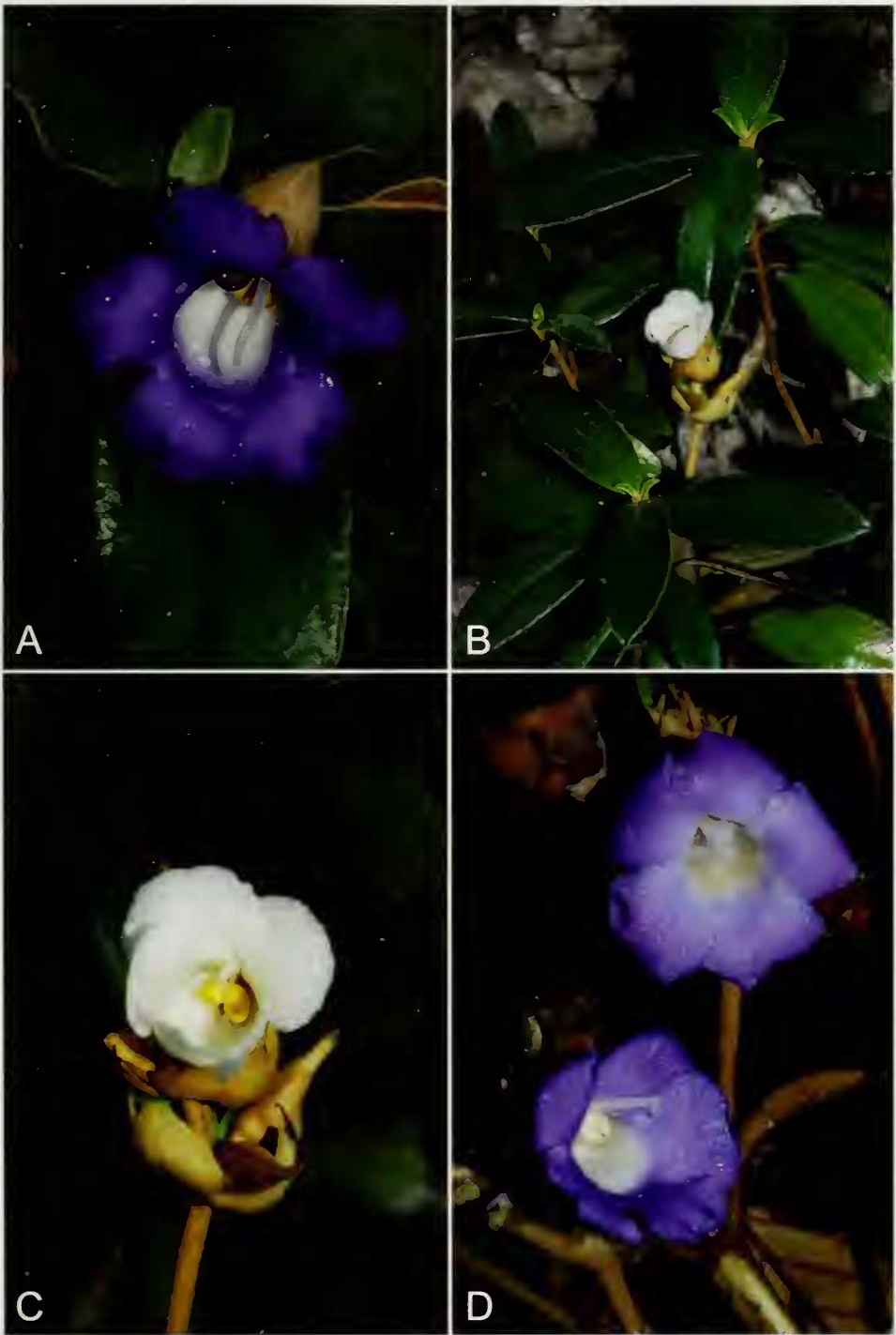
*Notes.* *Paraboea peninsularis* is similar to *Paraboea barnettiae* C.Puglisi in its habit and overall size, lanceolate leaves, long inflorescences and twisted cylindric capsules, but it differs in having acute leaf apices, rounded bract apices and white corollas.

This species was referred to as *Trisepalum* sp. nov. 2 in Puglisi et al. (2011).

***Paraboea phanomensis* Triboun & D.J. Middleton, sp. nov.** (Fig. 5D, Fig. 6)

*Paraboeae albidae* (Barnett) C.Puglisi magnitudine ubique magna, bracteis globosis et foliorum forma similis, sed foliorum pagina superiore glabra, bracteis cum apice acuto, inflorescentiis cum axibus ultimis dense fasciculatis et capsulis minoribus differt. TYPUS: *D.J. Middleton, P. Triboun, V. Chamchumroon, S. Saengrit & R. Simma 4365*, 7 September 2008, Thailand, Phanom District, Khlong Phanom National Park, Trail from Park headquarters (holo BK; iso BKF, E, K, KEP, L).

Lithophytic perennial herb to small shrub. Stem erect, 25–60 cm high, branches many, 20–40 cm long, 3–3.5 mm in diam., woody root stock robust and finely striate. Leaves many, 10–16 on each shoot, arranged densely opposite decussate; petiole 1.4–2 cm long, sulcate, covered with light brown woolly hairs; blade coriaceous, lanceolate, 4.5–8(–12) × 2–2.8(–3.7) cm, apex acute or subacute, base cuneate, margin crenate, glabrous or loosely covered with white arachnoid hairs above, glaucous and densely covered with light brown woolly hairs beneath, secondary veins 10–13 on each side of midrib, prominent beneath. Inflorescences 4–8, subterminal or axillary, compound monochasia, axis 1.5–3 cm long, 1–2 flowers at each node; peduncle slender, 3–6 cm long, 0.8–1 mm in diam., glaucous, hairs



**Fig. 5.** A. *Paraboea nobilis* Triboun & D.J. Middleton. B–C. *Paraboea peninsularis* Triboun & D.J. Middleton. D. *Paraboea phanomensis* Triboun & D.J. Middleton. (Photos: P. Triboun)

sparse; bracts globose,  $0.8-1 \times c. 0.8$  cm, hooded, apex sharply acute, outside light brown and densely covered with white woolly hairs, inside green and glabrous; pedicels 2–6 mm, unequal, densely covered with white or light brown woolly hairs. Calyx cotyliform, 3-lobed, almost free; posterior lobe oblong to elliptic,  $6-8.5 \times 3-4.5$  mm, apex sharply acute, margin fimbriate, 2 interior lobes linear to lanceolate,  $c. 7 \times c. 2$  mm, apex acute, margin fimbriate. Corolla campanulate; tube white or pale pink, (7–)1–1.3 cm long; lobes light blue, pink or pale blue, broadly globose or broadly ovate,  $(0.6-0.8-0.9 \times 0.9-1.3)$  cm, apex rounded, margin fringed. Stamens 2; filaments creamy white,  $c. 5.5 \times c. 2$  mm, geniculate, flattened; anthers  $c. 2.5 \times c. 4$  mm, yellow; staminodes 2–3, linear,  $c. 1$  mm long, white, medial staminode not apparent. Ovary ovoid,  $c. 5$  mm, densely covered with brown woolly hairs; style white, 6–8 mm long; stigma linguiform, 4–6 mm long, white. Capsules woody, cylindric to ellipsoid,  $2-2.7 \times 0.3-0.45$  cm, twisted, glaucous and densely covered with brown woolly hairs, surrounded by persistent calyx.

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* On limestone rocks at edge of evergreen forest, alt. 100–300 m.

*Phenology.* Flowering and fruiting in May to October.

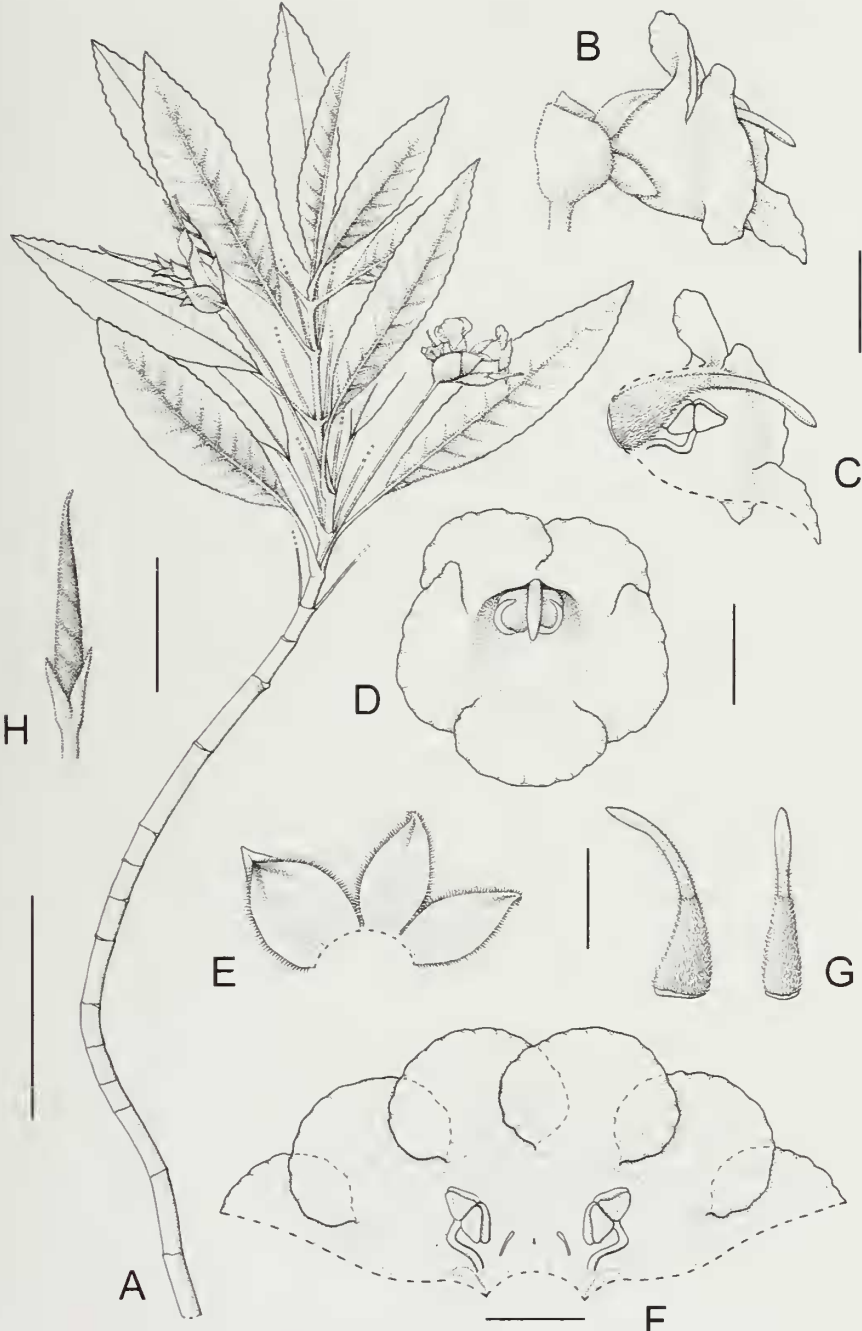
*Vernacular.* Sri Su Rat (ศรีสุราษฎร์).

*Etymology.* The specific epithet refers to the collection locality in Khlong Phanom National Park, Surat Thani province in Thailand.

*Proposed IUCN conservation assessment.* Least Concern. This species is known from several populations over a wide area. Some of these populations are not in protected areas and monitoring is necessary to assess whether this species may qualify for a threat category in the future.

*Notes.* *Paraboea phanomensis* is similar to *Paraboea albida* (Barnett) C. Puglisi in its large overall size, globose bracts and leaf shape, but it differs in the glabrous upper leaf surface, the acute apex to the bracts, inflorescences with densely clustered ultimate axes and smaller capsules (2–2.7 cm long in *P. phanomensis*, 2.3–3 cm long in *P. albida*).

Several new species from a range of families have been described from Khlong Phanom National Park in recent years (e.g. Lindsay & Middleton, 2004; Phuphathanapong, 2006; Lindsay et al., 2008; Inthachub et al., 2009) even though this is a relatively small National Park. It is fairly accessible and many of these species may eventually also be found in the more difficult terrain of the neighbouring Khao Sok National Park.



**Fig. 6.** *Paraboea phanomensis* Triboun & D.J.Middleton. **A.** Habit. **B.** Flower, lateral view. **C.** Flower, lateral view cross section. **D.** Corolla opening. **E.** Calyx opened out. **F.** Corolla opened out. **G.** Ovary and style front and lateral views. **H.** Twisted fruit. Scale bars: A = 5 cm; B–G = 0.5 cm; H = 1.5 cm. (Drawn by Claire Banks)

***Paraboea quercifolia* Triboun, sp. nov. (Fig. 7A)**

*Ab aliis speciebus generis combinatione characterum sequentium: caulis brevis tenuisque lignosus ad apicem cum foliis congestis, inflorescentiae pilis glandulis minutis viscidis dense obiectae, calyx 5-partitus cuius lobis anguste ovatis et corollae violaceo-caeruleae.* TYPUS: *P. Triboun* & *P. Yotliakaew* 4296, 18 June 2009, Thailand, Lopburi, Sri Samrong-Chibadan, Khao Tumbol, Wat Tham Wiweg Sri Sawat (holo BK; iso E).

Lithophytic perennial herb, solitary or in clumps, stem 5–10 cm high with 2–3 shoots, woody rootstock cracked and rough. Leaves 10–20, arranged in a dense rosette at the top of the stem; sessile; blade lanceolate, elliptic or oblong, 3–6.5 cm × 2.5–3.5 cm, the lower ones larger than the upper ones, apex acute or obtuse, margin crenate but entire near the base, green above, light brown beneath, secondary veins 4–5 on each side of midrib, obscure above, prominent beneath, both sides with dense glandular hairs and a sparse covering of arachnoid hairs. Inflorescences 1–4, subterminal, 2–4 times branched in each compound dichasium; peduncle red, 6–15 cm long, 2–3 mm in diam., covered with dense red multicellular glandular hairs, tips of hairs with yellow sticky substance; bracts linear, the upper ones strongly reduced; bracteoles reduced or absence; flowers paired; pedicels up to 3 cm long, those of a pair unequal in length. Calyx greenish brown, c. 5 mm long, fused at base for c. 1 mm, 5-lobed; lobes narrowly ovate, covered with dense tiny glandular hairs. Corolla violet-blue, with a short tube and spreading lobes; tube c. 4.5 mm long; 2 posterior lobes ovate or obovate, c. 5 × c. 5.5 mm, apex rounded; 3 anterior lobes orbicular to ovate, c. 7 × c. 6 mm, apex rounded, the middle one hooded at apex. Stamens 2, inserted near base of corolla tube; filament mauve, geniculate, c. 3 mm long, c. 0.8 mm wide; anthers yellow, c. 3 × c. 3 mm. Staminodes 2, white, ± triangular, 1–2 mm long, medial staminode not apparent. Disc annular. Ovary ovate, c. 2 mm long, green, covered with tiny glandular hairs. Style mauve, 3–4 mm long. Stigma capitate, yellowish brown. Capsules narrowly cylindric, 0.8–1 × c. 0.1 cm, twisted.

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* Mixed deciduous forest on summit of limestone hill, alt. 100–300 m.

*Phenology.* Flowering and fruiting in late May to August.

*Vernacular.* Cha Rue Si Bai Ko (ชาฤๅษีใบก้อ).

*Etymology.* The specific epithet refers to the oak-like, deeply crenate leaf margin.

*Proposed IUCN conservation assessment.* Critically Endangered (CR B1ab(iii,v)). This species is only known from the type locality which is in the grounds of a temple surrounded by farmland and prone to fire damage.

*Notes.* *Paraboea quercifolia* differs from all other species in the genus by the combination of a short and slender woody stem with congested leaves at top of stem, the inflorescences densely covered in minute sticky glandular hairs, the calyx 5-partite with narrowly ovate lobes and violet-blue corollas.

***Paraboea rosea* Triboun. sp. nov. (Fig. 7B)**

*Paraboeae arachnoideae Triboun magnitudine ubique magna, foliis rosulatis, partibus plantae plurimis pilis arachnoideis dense obtectis et floribus densis similis, sed in foliis cum pilis arachnoideis minus densis, foliis lanceolatis, pedunculis brevioribus, corollis rubescentibus et capsulis longioribus recedit.* TYPUS: *P. Triboun. P. Blenchitra & B. Sonsupab 3844*, 14 September 2007, Thailand, Krabi, Mu Koh Lanta, Koh Talabeng (holo BK; iso E).

Lithophytic perennial herb to subshrub. Stem erect, 10–40 cm high, 1–1.8 cm in diam., hard and woody, robust, grooved, cracked and rough, densely covered with petiole scars, covered with light whitish brown arachnoid hairs, woody root stock stout. Leaves 10–15, arranged in a dense rosette at the top of the stem; petiole 3–5.5 cm long, 5–7 mm in diam., densely covered with very light whitish brown arachnoid hairs; blade sub-coriaceous, lanceolate, 8–16 × 3–6.5 cm, apex acute or obtuse, base crenate or slightly attenuate, margin crenate, secondary veins 7–9 on each side of midrib, tertiary veins reticulate, densely covered with short multicellular glandular hairs but somewhat obscured by white arachnoid hairs above, densely covered with whitish brown arachnoid hairs beneath. Inflorescences 1–3, subterminal, compound pleiochasia, loosely congested 4–6 branches at each node, 3–6 orders of branching in each branch, 1–2 terminal orders mostly compound dichasia; peduncle 10–15 cm long, c. 2.5 mm in diam, sulcate, covered with white arachnoid hairs; bracts lanceolate, c. 1 × c. 0.2 cm, covered with white arachnoid hairs, flowers paired; pedicels 3–9 mm, covered with brown woolly hairs. Calyx green, red tinged at tips of lobes, fused for less than 0.5 mm at base, 5-lobed; lobes lanceolate, 1.5–1.8 × c. 0.7 mm, apex acute, sparsely covered with white hairs. Corolla pinkish red, with a short tube and spreading lobes; tube c. 2.5 mm; 2 posterior lobes ovate or orbicular, c. 3.5 × c. 2.5 mm, apex rounded, 3 anterior lobes obovate, c. 3 × c. 2 mm, the 2 lateral ones asymmetrical, apex rounded or obtuse. Stamens 2, inserted near base of corolla tube, surrounded by red markings; filament white, c. 2.5 mm, geniculate; anthers yellow, c. 2.5 × c. 2 mm; staminodes 2, strongly reduced. Ovary ovoid, c. 2 mm; style white to light green, c. 3 mm; stigma capitate, white or light brown. Capsules cylindric, 1–1.9 cm, 2–2.5 mm in diam., twisted.

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* Open sun or in shade on steep limestone cliffs, alt. 10–200 m.

*Phenology.* Flowering and fruiting in July to October.

*Vernacular.* Dao Pra Dab Pha (ดาวประดับผา).

*Etymology.* The specific epithet refers to the pinkish red colour of the corollas.

*Proposed IUCN conservation assessment.* Vulnerable (VU D1). This species is only known from the type locality which is in a legally protected area. Although, the exact size of the population is uncertain we estimate that it is < 1000 individuals.

*Notes.* *Paraboea rosea* is most similar to another new species, *Paraboea arachnoidea* Triboun, in its large overall size, the leaves in a rosette, the dense covering of arachnoid hairs on most parts and the dense flowers, but it differs in a less dense covering of arachnoid hairs on the leaves, lanceolate leaves, shorter peduncles (10–15 cm in *P. rosea*, 18–26 cm long in *P. arachnoidea*), pinkish red corollas and longer capsules (1–1.9 cm in *P. rosea*, 0.8–1 cm in *P. arachnoidea*).

***Paraboea sangwaniae* Triboun, sp. nov. (Fig. 7C–D)**

*Paraboeae axillari Triboun habitu haud frutescenti, foliorum in superficiebus ambabus cum venis secundariis tertiariisque prominentibus, inflorescentiis axillaribus et subterminalibus et capsula glabra similis, sed pedunculis robustis, corollis purpureis usque malvinis cum tubo albo ad pallide marronino et in tubo venis pallide viridibus, et capsulis majoribus differt.* TYPUS: *P. Triboun*, *P. Blenchitra* & *B. Sonsupab* 4039, 26 July 2008, Thailand, Chiang Rai, Mae Fa Luang, Doi Tung (holo BK; iso E).

Lithophytic perennial herb. Stem erect or trailing, 20–60 high, lower part 6–8 mm in diam, with old and dry persistent leaves. bark densely covered with brown woolly hairs giving a felt-like appearance. Leaves 8–12, opposite decussate, sometimes congested towards the apex; petiole 1.5–5 cm long, base amplexicaul, covered with woolly hairs; blade subcoriaceous, ovate or obovate, 7.5–12 × 4.7–5.5 cm, apex acute, base attenuate or oblique, margin crenate, secondary veins 8–10 on each side of midrib, tertiary veins reticulate, venation prominent on both sides; green with some red tinges, covered with multicellular glandular hairs above, covered with white woolly hairs beneath. Inflorescences 1–6, compound monochasia, subterminal or axillary; peduncle 4–8 cm long, c. 2.2 mm in diam., densely covered with white arachnoid hairs; second order branching c. 4 cm long, flowers 2–6, paired; bracts orbicular, c. 1.9 × c. 2.5 cm, apex acute, green and maroon, shiny above, glabrous; pedicel 1.2–1.7 cm long, c. 3.5 mm in diam., covered with brown woolly hairs. Calyx appressed to corolla tube, fused at base for 6–9 mm long, and then divided into lobes, the upper three lobes further fused and then divided, base of lobes slightly imbricate; lobes lanceolate, apex acute, upper 3 lobes c. 5 mm long, 4–5 mm wide; lower 2 lobes free, c. 1.2 × c. 0.4 cm; all 5 lobes green with maroon patches, glabrous. Corolla campanulate, c. 2.3 cm long; tube 2.6–

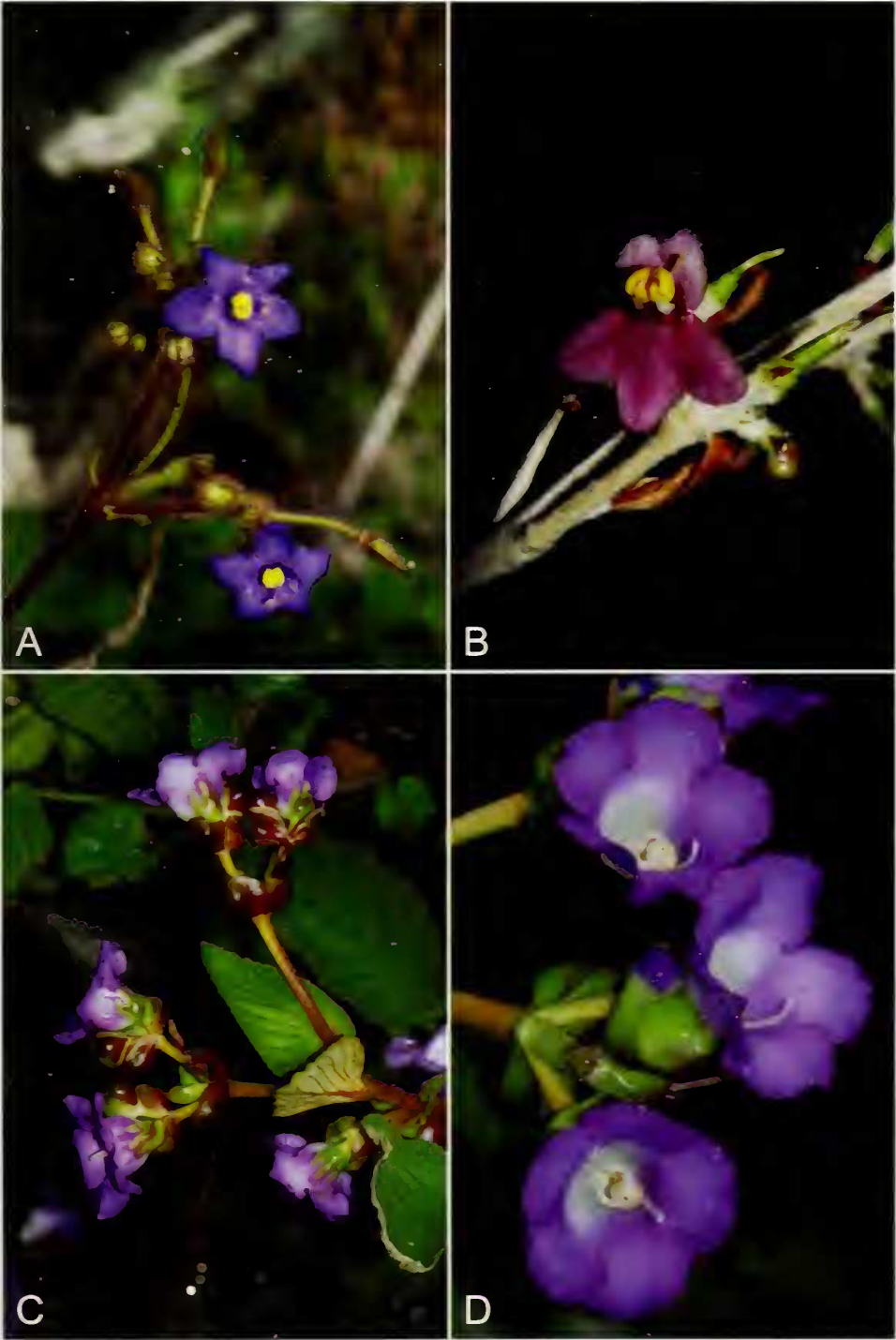


Fig. 7. A. *Paraboea quercifolia* Triboun. B. *Paraboea rosea* Triboun. C–D. *Paraboea sangwaniae* Triboun. (Photos: P. Triboun)

2.9 cm long, white to pale maroon with pale green veins, limb bilabiate, lower lobe 3-lobed, upper lobe 2-lobed, not symmetrical and not equal; lobes circular to widely ovate,  $1-1.2 \times 1.2-2$  cm, apex rounded to obtuse, pale purple to mauve. Stamens 2; filaments creamy white, flattened, somewhat parallel, 5–6 mm long, c. 1 mm in diam., fused to corolla tube near base; anthers semicircular in shape, c. 5 mm, creamy yellow and turning brown when very mature; staminodes 3, inserted at base of corolla tube, spathulate,  $3.5-4 \times$  c. 0.5 mm, white with yellow tip. Ovary ovoid to ellipsoid,  $4-5 \times 2.3-2.7$  mm; style  $4-10 \times 1-1.5$  mm, pale green, glabrous; stigma linguiform,  $4.5-6.5 \times 1.5-1.8$  mm wide, white, apex split into 2 lobes. Capsules ellipsoid,  $2.5-3.5 \times$  c. 0.4 cm, twisted, glabrous, calyx persistent.

*Additional specimen examined:* THAILAND. **Chiang Rai:** Mae Fa Luang District, Summit of Doi Tung,  $20^{\circ}19.6'N$   $99^{\circ}50.0'E$ , alt. 1510 m, 23 September 2008, *D.J. Middleton, P. Karaket, P. Triboun, U. Kawatkul & R. Meeboonya* 4572 (BK, BKF, E).

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* On open limestone summit, alt. 1000–1500 m.

*Phenology.* Flowering and fruiting in July to December.

*Vernacular.* Nagarinthra (นกรินทร์รา), name given by His Majesty King Bhumibol of Thailand.

*Etymology.* The specific epithet honours Princess Sangwan (1900–1995), the late Princess Mother of King Ananda Mahidol (Rama VIII) and King Bhumibol Adulyadej (Rama IX), under whose initiative the conservation and reforestation of the collection locality at Doi Tung in Chiang Rai in Thailand was established.

*Proposed IUCN conservation assessment.* Critically Endangered (CR B1ab(iii,v)). This species is only known from Doi Tung, has an Extent of Occurrence of  $< 100$  km<sup>2</sup> and is known from only one population. The area is not protected and there has been a reduction in the quality of the habitat through large scale tourism which has also led to a reduction in the number of mature individuals.

*Notes:* *Paraboea sangwaniae* is most similar to the new species *Paraboea axillaris* Triboun in its non shrubby habit, the secondary and tertiary veins prominent both abaxially and adaxially, the axillary and subterminal inflorescences and the glabrous capsule, but it differs in having robust peduncles, purple to mauve corollas with a white to pale maroon tube and pale green veins in the tube, and larger capsules (2.5–3.5 cm in *P. sangwaniae*, 1.8–2.2 cm in *P. axillaris*).

This species was referred to as *Trisepalum* sp. nov. 1 in Puglisi et al. (2011).

***Paraboea siamensis* Triboun, sp. nov.** (Fig. 8A–B)

*Paraboeae acauli* (Barnett) C. Puglisi habitu perenni suffruticoso, phyllotaxe ad instar rosulae, foliorum laminis ellipticis, pilis arachnoideis densis et flore magno similis sed foliis minoribus, bracteis calycibusque majoribus ac magis spectabilibus et corolla caerulea differt. TYPUS: *P. Triboun*, B. Sonsupab & P. Yothakaew 4565, 7 September 2010, Thailand, Tak, Umphang, Doi Hua Mot (holo BK; iso BKF, E).

Lithophytic perennial herb to subshrub; each plant with 1–5 branches, lower part of each branch with persistent old and decayed leaves; rootstock long, rough. Leaves 10–25, arranged in a dense rosette at the top of the stem; sessile or petiole very short; blade lanceolate to elliptic, 5–12 cm × 1.5–3.5 cm, the lower ones larger than the upper ones, apex acute, base attenuate and winged, amplexicaul to petiole and node, margin slightly crenate, both sides covered with white arachnoid hairs, more densely so beneath, secondary veins 5–8 on each side of midrib. Inflorescences 1–4, subterminal or axillary near shoot apex, a compound dichasium with 1 order of branching; peduncle 5–9 cm long, 2–2.5 mm in diam., covered with white arachnoid hairs; axis 1.2–1.5 cm long, covered by white arachnoid hairs; bracts reddish mauve in the upper half, broadly ovate, c. 2.5 cm long, apex rounded, margin erose, sparsely covered with white arachnoid hairs, uppermost bracts 1.8–2 cm long, c. 1.7 cm wide; flowers paired; pedicels c. 4 mm, covered with white arachnoid hairs. Calyx green, tube 4–5 mm long, c. 5 mm in diam., 3-lobed; lobes obovate, ovate or oblong, 1–1.4 × 0.7–1 cm, margin erose, sparsely covered with white hairs, each lobe closed and slightly imbricated. Corolla blue, campanulate; tube 1.2–1.8 cm long; posterior and anterior lobes nearly same shape and size, broadly ovate, orbicular or obovate, 6–8 × 0.9–1.1 cm, apex rounded or obtuse. Stamens 2, inserted near base of corolla tube; filaments white, geniculate, c. 5 mm long; anthers yellow, reniforme, c. 3 × c. 6 mm; staminodes 2, 2–3 mm long, medial staminode not apparent. Disc annular, c. 2 mm high. Ovary ovoid, c. 3.5 mm long, green, glabrous; style 1.3–1.5 cm long, white to light green; stigma minute, obcordately bilobed, yellowish brown. Capsules narrowly ovate, c. 1 cm long, slightly twisted, calyx persistent.

*Additional specimens examined:* Thailand, Tak, Um Phang, Doi Hua Mot, alt. 900 m, 23 April 2004, R. Pooma, K. Phattarahirankanok, S. Sirimongkul & M. Poopath 4606 (BKF, E, L).

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* Among rock on open limestone hill.

*Phenology.* Flowering and fruiting in July to November.

*Vernacular.* Sri Siam (ศรีสยาม).

*Etymology.* The specific epithet refers to the collection locality in Thailand, Siam being the former name for Thailand.

*Proposed IUCN conservation assessment.* Critically Endangered (CR B1ab(iii,v), D). This species is only known from a very small population of < 50 individuals. It is in a legally protected area but the site is prone to fire and is impacted by tourism.

*Notes.* *Paraboea siamensis* is unusual because although it is quite clearly part of the *Trisepalum* group it has a minutely capitate stigma rather than the linguiform stigma usually found in species traditionally placed in *Trisepalum*. It is most similar to *Paraboea acaulis* (Barnett) C.Puglisi in its perennial suffrutescent habit, rosette-like phyllotaxy, elliptic leaf blades, the dense covering of arachnoid hairs and the large flower, but it differs in the smaller leaves (5–12 cm long in *P. siamensis*, 6–14 in *P. acaulis*), more showy and larger bracts (1.8–2 cm in *P. siamensis*, c. 1.2 cm in *P. xylocaulis*) and calyces (1.4–1.9 cm long in *P. siamensis*, 1–1.2 cm long in *P. xylocaulis*), and the blue corolla.

***Paraboea takensis* Triboun, sp. nov.** (Fig. 8C–D)

*Paraboeae strobilaceo* (Barnett) C.Puglisi *magnitudine modica, foliis chartaceis, venatione prominenti et floribus albis similis sed foliis haud scabridis, bracteis ovatis vel naviculiformibus et floribus paucioribus recedit.* TYPUS: *P. Triboun* 3606, 14 July 2006, Thailand, Tak, Umphang, Doi Hua Mot (holo BK; iso E).

Lithophytic perennial herb. Stem erect, 20–50 cm high, c. 2.5 mm in diam., brownish grey, with 1–2 young shoots at the base of stem; woody root stock slender and finely striped. Leaves 8–15, loosely opposite decussate; upper pairs sessile, lower ones with petiole 1–2.5 cm long, glaucous, densely covered with white hairs; blade papery, lanceolate, elliptic or ovate, 3–10 × 1.4–3.3 cm, apex acute, base cuneate or attenuate, margin slightly crenate, slightly glaucous, covered with short glandular trichomes above, covered with brown woolly hairs beneath, secondary veins (6–)10–12 on each side of midrib, tertiary veins reticulate, venation prominent beneath. Inflorescences 2–5, subterminal, a single flower or in compound monochasia, with 1–2 orders of branching; peduncle 2.5–2.8 cm long, densely covered with white arachnoid hairs, bracts ovate or naviculiform, 1.2–1.5 × 8–1.1 cm, apex obtuse or acute, outside glaucous and sparsely covered with arachnoid hairs, inside green; pedicels to c. 1.2 cm, unequal, some nearly sessile, densely covered with white hairs. Calyx cotyliform, 3-lobed; lobes ovate or lanceolate, upper 3 lobes fused at base, c. 1.2 × 0.4–0.5 cm, the 2 lateral lobes covering the middle lobe, 2 lower lobes c. 1.2 × c. 0.6 cm, free. Corolla white, campanulate, tube c. 1.8 cm long, lobes broadly obovate or broadly ovate, 0.8–1.1 × 1.3–1.5 cm, apex rounded. Stamens 2; filaments creamy white, c. 3.5 mm long, geniculate; anthers light brown, c. 4.5 × c. 4.8 mm; staminodes 3, linear, c. 2.5 mm. Ovary ovoid, c. 3 mm, glabrous; style white, c. 7 mm long; stigma linguiform, c. 1.2 cm long, white. Capsules not seen.

*Distribution.* Endemic to Thailand. So far known only from the type locality.



Fig. 8. A–B. *Paraboea siamensis* Triboun. C–D. *Paraboea takensis* Triboun. (Photos: P. Triboun)

*Ecology.* On open limestone rock in mixed deciduous oak forest, alt. 600–1000 m.

*Phenology.* Flowering and fruiting in late June to October.

*Vernacular.* Khao Tog Yai (ข้าวตอกใหญ่).

*Etymology.* The specific epithet refers to the locality in Tak province in Thailand.

*Proposed IUCN conservation assessment.* Critically Endangered (CR B1ab(iii,v), D). This species is only known from a very small population of < 50 individuals. It is in a legally protected area but the site is prone to fire and is impacted by tourism.

*Notes.* *Paraboea takensis* is similar to *Paraboea strobilaceum* (Barnett) C. Puglisi in its moderate size, papery leaves, prominent venation and white flowers, but it differs in its non scabrid leaves, ovate or naviculiform bracts and fewer flowers (2–8 in *P. takensis*, 4–10 in *P. strobilaceum*).

***Paraboea tenuicalyx* Triboun, sp. nov. (Fig. 9A)**

*Paraboeae harrovianae* (Craib) Z.R.Xu in inflorescentibus pleiochasiis compositis, lobis calycis minimis linearibusque et corollis dilute malvinis similis sed apicibus foliorum acutis, pedunculis longioribus, inflorescentibus (pedunculi, bractaeae, pedicelli et calyces) sine pilis albis arachnoideis, et inflorescentibus magis laxis recedit. TYPUS: *P. Triboun* 3837, 28 August 2007, Thailand, Kanchanaburi, Tung Yai Naresuan Wildlife Reserve, Lai Wo Subdistrict, Ban Saneh Pawng area (Karen village) (holo BK; iso E).

Lithophytic perennial herb. Stem erect, 8–18 cm high, solitary, 4–6 mm in diam, densely covered with greyish brown woolly hairs, root stock short and robust, sometimes young shoots sprouting from root stock. Leaves 4–8, opposite decussate, slightly congested at the apex of the stem; petiole (2–)4–8(–12) cm long, 1.5–2.5 mm in diam., densely covered with brown woolly hairs; blade coriaceous, lanceolate or ovate, 8–17 × 3.5–6.5 cm, apex acute, base cuneate or obtuse, margin indistinctly crenate, glaucous beneath, secondary veins 8–11 on each side of midrib, obscure above, prominent beneath; glabrous above, densely covered with short light brown woolly hairs beneath. Inflorescences 1–2, subterminal, compound pleiochasia, 4–6 branches at each node, each branch with 4–5 orders of branching; peduncle 30–60 cm long, 3–4.5 mm in diam., densely covered with light brown woolly hairs; bracts linear, 1–2.5 × 0.1–0.5 cm, apex acute, the upper ones strongly reduced; flowers paired; pedicels slender, 3–7 mm long, glabrous. Calyx very small, fused at base for 1–1.5 mm, 5-lobed; lobes narrowly linear, 1–1.5 × 0.2–0.3 mm, apex obtuse, glabrous. Corolla light mauve, with a short tube and spreading lobes; lobes widely ovate, orbicular or obovate, 2–4 × 2.5–4 mm, apex rounded or obtuse. Stamens 2; filament light green, slightly geniculate, c. 2 mm long; anthers yellow, reniforme, c. 1.8 × c. 2 mm; staminodes 2, c. 0.8 mm long, median staminode not apparent. Ovary ovoid, c. 2.5 mm long, light green, glabrous;

style c. 2.5 mm long, white; stigma capitate, white. Capsules slender, narrowly cylindric,  $2\text{--}2.5 \times c. 0.1$  cm, twisted, glabrous.

*Additional specimens examined:* THAILAND. **Kanchanaburi:** Kin Sayok, about 120 km NW of Kanchanaburi, alt. 100–150 m, 4 August 1946, *A. Kostermans 1451* (US); Thong Pha Poom, 4 July 1973, *J.F. Maxwell 73-103* (AAU); Sangklaburi, Toong Yai Naresuan Wildlife Reserve, Lai Wo subdistrict, Ban Saneh Pawng area (Karen village), 300 m, 11 October 1993, *J.F. Maxwell 93-1223* (L); between Huay ban kao and Kritee, alt. 500 m, 4 July 1973, *R. Geesink & C. Phengkhilai 6084* (AAU); near Neeckey, near Wangka, alt. 150 m., *G. den Hoed 580* (K).

*Distribution.* Endemic to Thailand. So far known only from Kanchanaburi Province.

*Ecology.* On limestone rocks in dry evergreen to mixed deciduous forest, alt. 300–500 m.

*Phenology.* Flowering and fruiting in late June to November.

*Vernacular.* Khao Tok Phra Nares (ข้าวตอกพระนเรศ).

*Etymology.* The specific epithet refers to the minute calyces.

*Proposed IUCN conservation assessment.* Vulnerable (VU B1ab(iii,v)). This species is quite widespread within Kanchanaburi and most populations are in legally protected areas. However, there are fewer than 10 populations and some of these populations are prone to fire damage from neighbouring farming practices leading to a nett erosion in the quality of the habitat and the number of mature individuals.

*Notes.* Several of the paratypes listed above were included in *Paraboea harroviana* (Craib) Z.R.Xu var. *harroviana* by Xu et al. (2008) although they did note that the material from Kanchanaburi was morphologically distinct. With additional material and field observations we conclude that these populations form a distinct species differing from *Paraboea harroviana* in leaf apex shape, longer peduncles (30–60 cm in *P. tenuicalyx*, 10–20 cm in *P. harroviana*), laxer inflorescences, and the lack of white arachnoid hairs on all inflorescence parts.

***Paraboea vachareea* Triboun & Sonsupab, sp. nov.** (Fig. 9B)

*Paraboeae harrovianae* (Craib) Z.R.Xu *magnitudine ubique modica, dichasio composito congesto et corollis dilute caeruleis similis, sed foliis lanceolatis cum apicibus acutis et inflorescentiis minoribus differt.* TYPUS: *P. Triboun*, B. Sonsupab & P. Yothakaew 4566, 8 September 2010, Thailand, Tak, Umphang, Palata (holo BK; iso E).

Lithophytic perennial herb. Stem erect, 10–25 cm high, 3–4 mm in diam., with a few twigs and branches 2–5 cm long, 2–5 mm in diam., woody root stock slender and

finely striped. Leaves 9–18, densely opposite decussate; petiole brown, 3–8 cm long, covered with woolly brown hairs; blade coriaceous, lanceolate, 5–11 cm  $\times$  3–5.5 cm, apex acute, base cordate or cuneate, margin crenate, shiny green above, covered by short dark woolly brown hairs beneath, secondary veins 5–7 on each side of midrib. Inflorescences 1–5, subterminal, c. 3 orders of branching in each compound pleiochasia, some congested with 4–8 branches on each order; peduncle (1.5–)10–25 cm long, covered by woolly brown hairs; bracts linear, 0.6–1.5 cm long, the upper ones strongly reduced; flowers paired; pedicels 6–7 mm, glabrous. Calyx brownish green, fused less than 1 mm at base, 5-lobed; lobes narrowly linear, c. 2.5 mm long, glabrous. Corolla light blue, campanulate; tube 0.5–1 cm long; 2 posterior lobes obovate, 4–5  $\times$  c. 2.5 mm, apex rounded; 3 anterior lobes obovate, c. 5–5.5  $\times$  3 mm, apex rounded, the middle one largest. Stamens 2, inserted near base of corolla tube; filament light green, c. 2 mm long, geniculate; anthers white, c. 2  $\times$  c. 3.5 mm. Staminodes 3, narrowly linear, 1–2 mm long. Ovary ovoid, c. 3  $\times$  c. 1.5 mm long; style white, c. 3 mm long; stigma capitate, white. Capsules narrowly cylindric, twisted.

*Distribution.* Endemic to Thailand. So far known only from the type locality.

*Ecology.* On limestone rock in dry evergreen to mixed bamboo deciduous forest, alt. 600–900 m.

*Phenology.* Flowering and fruiting in August to November.

*Vernacular.* Va Cha Ree Phun (วัชรพรรณ).

*Etymology.* The specific epithet honours Mrs. Vacharee Prachasaisoradej, a senior botanist at the Bangkok Herbarium (BK), who encouraged the first author in the field of plant taxonomy.

*Proposed IUCN conservation assessment.* Critically Endangered (CR B1ab(iii,v), D). This species is known from only one small population of fewer than 50 individuals. Although it is in a legally protected area the population is prone to fire damage from neighbouring farming practices.

*Notes.* The type of inflorescence in this species is found in many species of *Paraboea*, particularly in Thailand. It is most similar to *Paraboea harroviana* (Craib) Z.R.Xu in its size and the light blue corollas. It can be distinguished by its lanceolate leaves with an acute apex and its dense inflorescences.

***Paraboea xylocaulis* Triboun, sp. nov.** (Fig. 9C–D)

*Paraboeae siamensi* Triboun planta magna robusta, foliis lanceolatis, calyce spectabili et corollis pallide purpureis similibus sed calycibus bracteisque minoribus et foliis, pedunculis pedicellisque cum pilis albis arachnoideis obtectis differt. TYPUS: *P.*

*Triboun, B. Sonsupab & P. Yothakaew 4585*, 25 September 2010, Thailand, Border of Krabi-Phangnga bay, Pa Koh (holo BK; iso BKF, E).

Lithophytic perennial herb or small shrub. Stem woody, up to 70 cm high, with many twigs and branches, 15–20 cm long, 5–1.5 cm in diam., hanging from cliff but then with upright shoots, bark greyish brown, cracked and rough, lower part of each branch with persistent old and decayed leaves; root stock woody, robust, cracked and rough. Leaves 8–15, densely opposite decussate or 3-whorled, congested at the apex; appearing sessile but actually a winged petiole 1.2–5 × 0.25–0.5 cm, covered with light brown arachnoid hairs and brownish orange hairs along the midrib; blade coriaceous, lanceolate, 2.7–7.5 × 1.4–2.5 cm, apex acute, base attenuate, margin indistinctly crenate, densely covered with multicellular glandular hairs above, densely covered with brown woolly hairs beneath, secondary veins 8–10 on each side of midrib. Inflorescences 6–20 (2–6 on each branch), subterminal, in 1 pair of monochasia, rarely compound monochasia; peduncle c. 1 cm long, covered with brownish orange woolly hairs; bracts brownish green, globose, c. 1.2 × c. 1 cm, hooded, apex rounded, glabrous; flowers paired; pedicels 3–9 mm long, unequal, glabrous. Calyx shiny green with red margin, 3-lobed, almost free; lobes elliptic to oblong, 1–1.2 cm long, the posterior lobe 7–8 mm wide, apex obtuse or shallowly 2–3-lobed, the inferior lobes 5–5.5 mm wide, apex obtuse, glabrous. Corolla campanulate; tube light purple, c. 1.2 cm long; lobes purple, orbicular or broadly ovate, 0.8–0.9 × 0.9–1.2 cm, apex rounded. Stamens 2, inserted near the base of corolla tube; filament white, c. 6 mm long geniculate; anthers white or creamy white, c. 3 × c. 3 mm; staminodes 3, white, linear, 0.5–2 mm, the middle one smaller than the lateral ones. Ovary creamy yellow, oblong to ovoid, c. 3 mm long; style white, c. 1 cm long, covered with glandular hairs; stigma linguiform, c. 5 mm, white. Capsule ovoid, c. 1.5 × c. 0.85 cm, green tinged red, glabrous, surrounded by persistent calyx.

*Additional specimens examined*: THAILAND. **Krabi**: Koh Hin Bai, 31 October 2006, *P. Triboun* 3674 (BK, E).

*Distribution*. Endemic to Thailand. So far known only from the type locality.

*Ecology*. On steep cliffs on limestone islands, alt. 30–150 m.

*Phenology*. Flowering and fruiting in August to November.

*Vernacular*. Cha Ha Nu Man (ชาหนุมาน).

*Etymology*. The specific epithet refers to the distinct woody stem of this plant; *xylo* (Gk.) = woody, *caulis* = stem.

*Proposed IUCN conservation assessment*. Critically Endangered (CR D). Although this species is only known from the type locality this is in a legally protected area. However, the population contains fewer than 50 individuals.

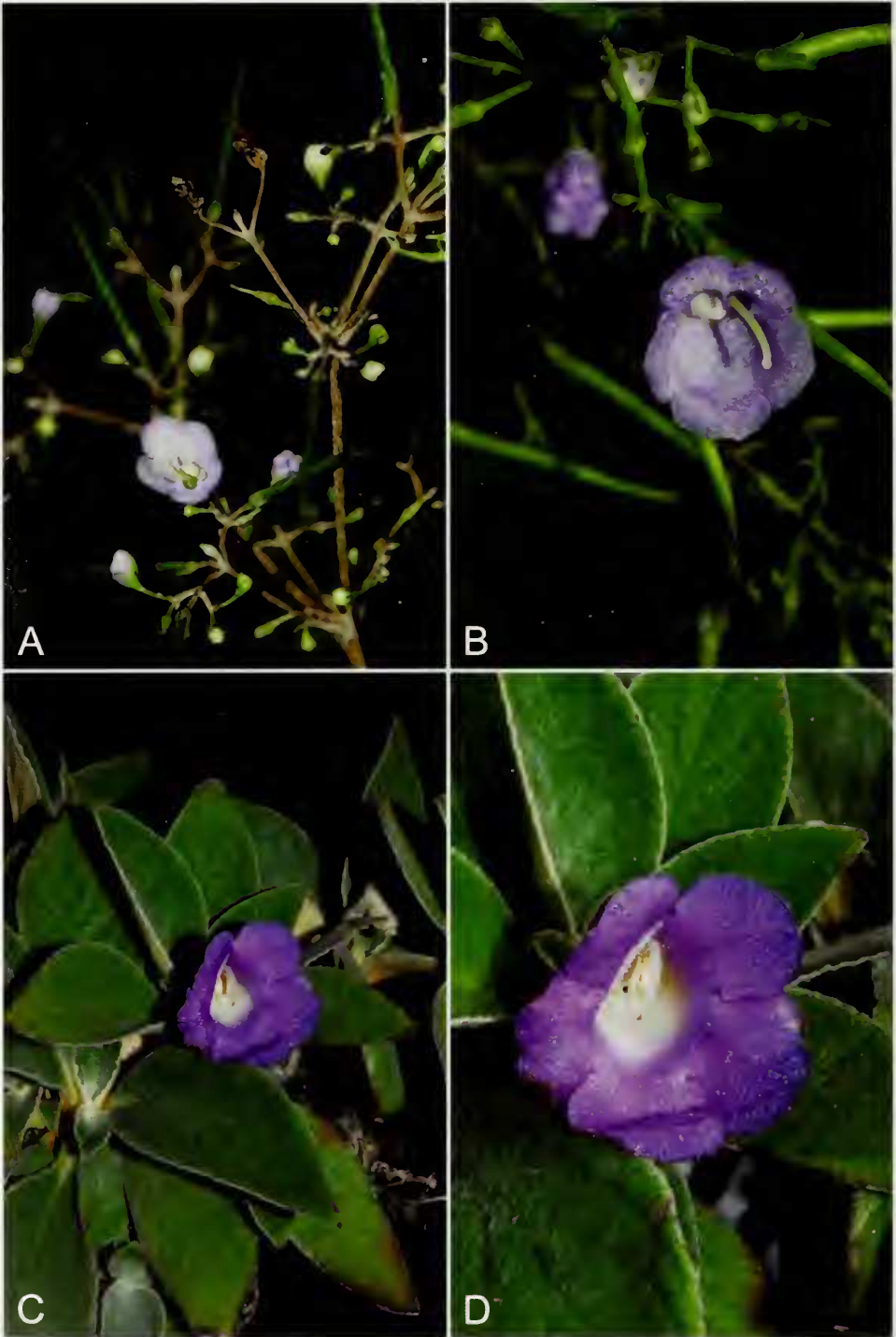


Fig. 9. A. *Paraboea tenuicalyx* Triboun. B. *Paraboea vachareea* Triboun & Sonsupab. C–D. *Paraboea xylocaulis* Triboun. (Photos: P. Triboun)

**Notes.** *Paraboea xylocaulis* is most similar to the new species *Paraboea siamensis* Triboun in being a large and robust plant, the lanceolate leaves, showy calyx and blue corollas, but it differs in the smaller calyces (1–1.2 cm long in *P. xylocaulis*, 1.4–1.9 cm long in *P. siamensis*) and bracts (c. 1.2 cm in *P. xylocaulis*, 1.8–2 cm in *P. siamensis*) and the covering of white arachnoid hairs on the leaves, peduncles and pedicels.

This species was referred to as *Trisepalum* sp. nov. 3 in Puglisi et al. (2011).

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## References

- Burt, B.L. (1984) Studies in the Gesneriaceae of the Old World: XLVII. Revised generic concepts for *Boea* and its allies. *Notes Roy. Bot. Gard. Edinburgh* 41: 401–452.
- Chen, W.H., Möller, M., Shui, Y.M. & Zhang, M.D. (2008) A new species of *Paraboea* (Gesneriaceae) from a karst cave in Guangxi, China, and observations on variations in flower and inflorescence architecture. *Bot. J. Linn. Soc.* 158: 681–688.
- Clements, R., Sodhi, N.S., Schilthuizen, M. & Ng, P.K.L. (2006) Limestone karsts of Southeast Asia: imperiled arks of biodiversity. *BioScience* 56: 733–742.
- Inthachub, P., Vajrodya, S. & Duyfjes, B.E.E. (2009) Review of the genus *Stichoneuron* (Stemonaceae). *Edinburgh J. Bot.* 66: 213–228.
- IUCN (2001) *IUCN Red List Categories and Criteria, Version 3.1*. Gland and Cambridge: IUCN Species Survival Commission.
- Kiew, R. (2010) Two new species of *Paraboea* (Gesneriaceae) from Peninsular Malaysia and Thailand. *Edinburgh J. Bot.* 67: 209–217.
- Lindsay, S. & Middleton, D.J. (2004) *Adiantum phanomensis* (Adiantaceae), a new fern species from Peninsular Thailand. *Harvard Pap. Bot.* 8: 137–140.
- Lindsay, S., Middleton, D.J. & Suddee, S. (2008) Two new species of ferns from Thailand. *Thai Forest Bull., Bot.* 36: 46–51.
- Middleton, D.J., Puglisi, C., Triboun, P. & Möller, M. (2010) Proposal to conserve *Paraboea* against *Phylloboea* and *Trisepalum* (Gesneriaceae). *Taxon* 59: 1603.
- Middleton, D.J. & Triboun, P. (2010) Two new species of *Petrocosmea* (Gesneriaceae) from Thailand. *Thai Forest Bull., Bot.* 38: 42–47.

- Phuphathanapong, L. (2006) New taxa of *Aristolochia* (Aristolochiaceae) from Thailand. *Thai Forest Bull., Bot.* 34: 179–194.
- Puglisi, C., Middleton, D.J., Triboun, P. & Möller, M. (2011) New insights into the relationships between *Paraboea*, *Trisepalum* and *Phylloboea* (Gesneriaceae) and taxonomic consequences. *Taxon* 60: 1693–1702.
- Triboun, P. & Middleton, D.J. (2010) A new species of *Damrongia* (Gesneriaceae) from Thailand. *Thai Forest Bull., Bot.* 38: 108–110.
- Weber, A. (2004) Gesneriaceae. In: Kubitzki K. & Kadereit, J.W. (eds.) *The families and genera of vascular plants*, volume 7. *Flowering plants: Dicotyledons; Lamiales (except Acanthaceae including Avicenniaceae)*. Pp. 63–158. Berlin & Heidelberg: Springer.
- Xu, Z., Burtt, B.L., Skog, L.E. & Middleton, D.J. (2008) A revision of *Paraboea* (Gesneriaceae). *Edinburgh J. Bot.* 65: 161–347.